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NINTH ANNUAL REPORT

OF THE

BOARD

OF

METROPOLITAN SEWERAGE
COMMISSIONERS,

FOR THE

YEAR ENDING SEPTEMBER 30, 1897.

7270

BOSTON :

WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 POST OFFICE SQUARE.

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J. C. Blandell

Mar 17, 1898

Rept. of the

State of

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NOTES TO

Commonwealth of Massachusetts.

To the Honorable the Senate and the House of Representatives.

The Board of Metropolitan Sewerage Commissioners, created by chapter 439, Acts of 1889, presents its annual report, which is the ninth since its organization, and covers the year ending Sept. 30, 1897.

In our report for 1896 (Public Document No. 45, 1897) the practical completion of the north metropolitan system was announced. Chapter 414 of the Acts of 1896, as amended by chapter 88 of the Acts of 1897, authorized the extension of this system to include a portion of the town of Wakefield, and made an appropriation therefor; while chapter 436 of the Acts of the latter year authorized and instructed this Board to provide an additional outlet for the town of Stoneham, and provided the means therefor. Both of these branches will be found more fully treated of under the north metropolitan system, sections 50 and 51. In our fourth annual report (Public Document No. 45, 1893) this Board announced that "the Charles River valley system has been completed and in use since early in April" (1892).

The work of construction has progressed steadily upon the Neponset valley system, and many of the sections thereon that were in the course of construction at the time our last report was rendered have been completed, while contracts have been made during the year for the remaining sections upon this system, and some of these sections are also completed at this time (Oct. 1, 1897). Your attention is called to the report of our chief engineer, and the tables following in connection with this report, for fuller details.

NORTH METROPOLITAN SYSTEM.

The following settlements for land taken upon this system have been made during the year : —

By deed of release, dated the 8th of October, 1896, Stephen P. Weld for himself, and as trustee, releases to the Commonwealth “all my claims and demands for damages” and “all claims and demands of Saml. B. Whittemore” and others, for a taking made by this Board, dated Jan. 7, 1893, and recorded with Middlesex South District Deeds, book 2169, page 457. Weld’s deed is recorded in Middlesex South District Deeds, book 2569, page 242, and is accompanied by two other deeds, one from Saml. B. Whittemore, trustee, and others, assigning to said Weld “all and singular our claims and demands against the Commonwealth” by reason of said taking. This deed is recorded with Middlesex South District Deeds, book 2569, page 241. A further quit-claim from Saml. B. Whittemore and Grace T., his wife, of the land included within said taking, accompanies deed of said Weld, being recorded with Middlesex South District Deeds, book 2569, page 244. These deeds cover a strip of land along Alewife Brook in Cambridge, near where it crosses North Avenue in said city. A deed of Louville V. Niles, dated Nov. 2, 1896, releases rights in land in Winchester included within a taking made by this Board July 14, 1893, and recorded with Middlesex South District Deeds, book 2210, page 162. Said deed from Niles is recorded in Middlesex South District Deeds, book 2539, page 336. And the said Louville V. Niles, by deed dated Nov. 2, 1896, releases to the Commonwealth rights in a certain parcel of land in said Winchester included within a taking made by this Board June 2, 1894, and recorded with Middlesex South District Deeds, book 2282, page 388. The latter deed of Niles is recorded with Middlesex South District Deeds, book 2539, page 334, and is accompanied by a deed from Clara

B. Kimball to said Niles of rights in a certain strip of land in the town of Winchester included within the same taking, which deed is recorded with Middlesex South District Deeds, book 2539, page 333. The first deed of said Niles includes land on Abbajona River in Winchester, and the second deed includes the land taken from Clara B. Kimball by the aforesaid taking, dated June 2, 1894, in said Winchester. Mary E. Davren of Cambridge, by deed dated Dec. 11, 1896, releases to the Commonwealth land in Cambridge included within a taking made by this Board Feb. 6, 1893, recorded with Middlesex South District Deeds, book 2174, page 219. The said deed is recorded with Middlesex South District Deeds, book 2539, page 342. Samuel H. Holt of Cambridge, by a deed dated Dec. 30, 1896, and recorded with Middlesex South District Deeds, book 2539, page 341, releases to the Commonwealth land in said Cambridge included within a taking made July 19, 1893, and recorded with Middlesex South District Deeds, book 2210, page 481. Charles Foster also releases to the Commonwealth by deed dated Jan. 11, 1897, recorded with Middlesex South District Deeds, book 2539, page 340, land in Cambridge included within the same taking. Settlement was made with the Bay State Brick Company for damages to land in Cambridge included in taking dated Jan. 7, 1893, and recorded with Middlesex South District Deeds, book 2169, page 457, the said company at its request being allowed to give the Board a satisfactory receipt for the money paid. Walter Russell and others, by deed dated April 21, 1897, release to the Commonwealth "rights, privileges and easements" in land in Arlington included within a taking made by this Board April 27, 1895, and recorded with Middlesex South District Deeds, book 2361, page 45. The said deed is recorded with Middlesex South District Deeds, book 2559, page 306. George A. Blaney and others, by deed dated May 15, 1897, also release the Commonwealth for damages by reason of a taking made at the same time of land in Somerville. The latter deed is recorded with Middlesex South District Deeds, book 2569, page 246.

Damages sustained by sundry persons in their real estate included within takings made at various times by this Board

were paid by the Commonwealth upon executions issued from the superior court, as follows: January, 1897, Edmund Reardon, Cambridge, included within a taking made Feb. 6, 1893, and recorded with Middlesex South District Deeds, book 2174, page 219. For this the Commonwealth has received a release from said Reardon, which is recorded with the aforesaid Registry, book 2539, page 337. On this section the Commonwealth has also received from said Reardon a release of land belonging at the time of taking to Michael J. Egan, which release is recorded with Middlesex South District Deeds, book 2559, page 304, and is accompanied by a deed from said Egan to Reardon, assigning all claims for damage to him. The last deed is recorded with Middlesex South District Deeds, book 2559, page 303. In the same manner the Commonwealth settled with said Reardon for two parcels of land included within the taking dated March 25, 1893, and recorded with Middlesex South District Deeds, book 2183, page 245. A deed from Edmund Reardon, recorded with Middlesex South District Deeds, book 2539, page 338, releases to the Commonwealth land included in one lot, while a deed from Ellen M. Reardon, his wife, recorded with Middlesex South District Deeds, book 2539, page 339, releases land on said section included in another lot. March, 1897, Cochrane Carpet Company, Malden, and John Cochrane, Jr., Malden, included within a taking recorded with Middlesex South District Deeds, book 2124, page 123. Samuel Cabot, for damage to his lamp-black factory on Marginal Street, East Boston, said street being included within a taking dated Aug. 1, 1891, recorded with Suffolk Deeds, book 2010, page 474. Said Cabot claimed damage to his factory on said street by reason of the construction of the sewer therein.

LAND TAKINGS.

In our last report, page xix, in speaking of the extension of this system to Wakefield, we called attention to the fact that our engineer considered the appropriation of thirty thousand dollars too small, and we recommended that the additional sum of five thousand dollars be appropriated.

Chapter 88 of the Acts of 1897 made the additional appropriation asked for, and enabled this Board to pay for so much of the local sewer in Melrose constructed by said town, and described in chapter 414 of the Acts of 1896 for the extension of the sewer to Wakefield. On Nov. 21, 1896, this Board executed a deed, recorded with Middlesex South District Deeds, book 2515, page 545, taking “for the said Commonwealth the sewers owned by the town of Melrose and already constructed under the following-described lands, all situated in said Melrose, in the county of Middlesex, and the right to carry and conduct under the said lands and therein to construct, to operate and forever to maintain an underground main sewer and connecting sewers, drains, man-holes and underground appurtenances, and to repair and renew the same;” through Wyoming Avenue and Hurd Street, crossing the location of the Boston & Maine Railroad to Berwick Street; thence *via* Berwick, Grove, Myrtle and Essex streets to the northerly line of Emerson Street at its junction with Tremont Street, and in said Tremont Street to the northerly line of Lake Avenue produced, as shown on three plans of even date recorded with the taking. On April 24, 1897, the Board executed a deed taking an easement in lands and streets situated mostly in Melrose and partly in Wakefield necessary for constructing an extension of the metropolitan sewerage system to the villages of Greenwood and Boyntonville, under the provisions of chapter 414, Acts of 1896, which deed is recorded with Middlesex South District Deeds, book 2559, page 301. The Board was further instructed by chapter 436, Acts of 1897, to construct branch sewers in Melrose to the Stoneham line, as an additional outlet for the sewage of the town of Stoneham, and in accordance with said instructions executed on July 17, 1897, a deed, recorded with Middlesex South District Deeds, book 2581, page 353, taking the right of way necessary for said sewer, as shown on plans drawn by Wm. M. Brown, Jr., chief engineer, of even date, and recorded with said taking.

The Legislature of 1897 also passed an act, chapter 520, Acts of 1897, providing “for the addition of a portion of the town of Lexington to the metropolitan sewerage system,” which was approved on June 11 of that year. Section

11 of said act provides that it “shall take effect upon its acceptance by a vote of a majority of the legal voters of said town of Lexington present and voting thereon at a legal meeting called for that purpose within one year from the date of its passage.”

This Board has never been notified of the acceptance of said act by the town of Lexington, but are informed that the said town intends to seek amendments thereto from the present Legislature. By the aforesaid act seventy thousand dollars was appropriated to carry out the provisions thereof, but, as this Board has received no notice of its acceptance, the work has not been entered upon.

CONTRACTS.

Contracts for the construction of sections 50 (Wakefield branch) and 51 (Stoneham branch) are the only contracts for construction made by this Board on this system during the past year. Bids for the former were received and opened April 24, 1897, a full list of which will be found in Table A of the Appendix. The bids for the latter were received and opened on July 3, 1897, and Table A of the Appendix shows the bids received at that time. On the former section the Board at its meeting on May 1, 1897, accepted the bid of the John Booth Company, and fixed the bond at \$3,000; this was furnished, with the American Surety Company of New York as surety, and the contract duly executed. On section 51 the A. W. Bryne Construction Company, the lowest bidder, was awarded the contract, and furnished surety, consisting of Wm. G. Nash of Somerville and E. O. Glidden of Cambridge, for \$1,500, which was duly accepted by the Board, and the contract executed with them for the construction of the section.

These two sections add about $2\frac{3}{4}$ miles to this system, and will probably be completed early in January (1898). When they are completed there will be about 45.65 miles of sewer in this system.

The engineer's report herewith contains a full account of the progress of the work on said sections.

OTHER CONTRACTS.

On July 1, 1897, a contract was executed with the Vacuum Oil Company for two years for supplying the oil to be used at the various pumping stations, and at various times contracts have been executed for supplying said pumping stations with the necessary coal for operating the same. Table A in the Appendix contains a list of bids received at various times for the purchase of coal.

The following contract with John P. Squire & Co., owners of a slaughtering establishment in Cambridge and Somerville, and similar contracts with the New England Dressed Meat and Wool Company and the North Packing and Provision Company, both of Somerville, were after due consideration executed by this Board the twenty-eighth day of October, 1896, and were all of them placed on record in Middlesex South District Registry, as follows: that of John P. Squire & Co., book 2510, pages 424 to 428 inclusive; that of the North Packing and Provision Company, book 2510, pages 420 to 424 inclusive; that of the New England Dressed Meat and Wool Company, book 2510, pages 429 to 432 inclusive. In each case a plan showing the premises accompanies the contract. We give a copy of the contract with John P. Squire & Co., the others containing the same general provisions:—

THE COMMONWEALTH OF MASSACHUSETTS BY THE BOARD OF METROPOLITAN SEWER COMMISSIONERS AND THE JOHN P. SQUIRE & CO., A CORPORATION ORGANIZED UNDER THE LAWS OF THE STATE OF MAINE, AGREE WITH EACH OTHER AS FOLLOWS:—

I.

This agreement is in reference to the disposal and conducting into the metropolitan sewer of the sewage and waste water from the premises of said company, situated partly in Somerville and partly in Cambridge, in the county of Middlesex. The output into sewers from said premises and from the establishments of said company thereon shall be considered as divided into three classes: first, sewage, which term, as used in this agreement, shall be construed and understood to mean what is generally understood by the term “sewage,” namely, water polluted within said premises or establishments and such polluted water as is ordinarily discharged into sewers; second, waste water, which term shall be

construed and understood to mean salt water or other water, used with engines, condensers, refrigerating apparatus, or for cooling or other purposes, with any apparatus or machinery, or conducted through and out of the premises in pipes without being discharged within the premises and polluted therein, or, in general, water which is discharged from the premises in the same condition, as to purity, as it was in when it entered the premises; third, surface water, which term shall be construed and understood to mean roof water and water falling upon the surface of the ground. It will further explain the meaning of said term "waste water," and one object of this agreement, to say that said company now uses large quantities of salt water, brought through its own pipes from Miller's River, for condensing purposes and with its engines and refrigerating apparatus, which water is discharged into the sewers; and the principal object of this agreement is to keep such of said water as is waste water, as hereinbefore defined, or any substitute therefor, out of the metropolitan sewer, when the Board of Metropolitan Sewer Commissioners shall, as hereinafter provided, be of the opinion that such metropolitan sewer should no longer, either directly, or indirectly through other sewers, receive such waste water.

II.

Referring to the plan, hereto annexed as a part hereof, and marked "Plan A," said sewage and waste water are to be conducted into the metropolitan sewer through an independent sewer and an independent connection (that is to say, independent of the present sewers of the city of Somerville), it being understood that independent sewers are to be constructed by said city outside of the premises of the hereinafter-named companies for conducting away into the metropolitan sewer the sewage and waste water from the premises of said company and of the New England Dressed Meat and Wool Company and the North Packing and Provision Company, as shown and laid down on said plan, said Board of Metropolitan Sewer Commissioners having given their consent that the city of Somerville may construct such independent connection and the connections of the Somerville sewers with the metropolitan sewer, in the manner as shown and laid down on said plan. Said surface water is not to go into and through said independent connection, but is to be conducted into the present sewers of the city of Somerville, and thus through them ultimately into the metropolitan sewer.

III.

The Commonwealth is to pay no part of the expenses of any sewers or connections referred to in this agreement, such expenses

to be arranged for between said company and said city of Somerville, as such company and city may determine.

IV.

Said company is to pay to the Commonwealth the sum of one dollar for every million gallons of waste water from the premises or establishments of said company, which may flow or be discharged (either immediately or ultimately through other sewers) into the metropolitan sewer, the quantity to be ascertained and computed by the engineer of the Metropolitan Sewer Commission, in such manner as he shall deem best, and bills to be presented by the Commonwealth to said company semi-annually. All waste water shall be conducted into and through man-holes, to be built by said company and on its premises at or near the outlet point of each waste water pipe into the sewer, details of the construction and location of such manholes to be subject to the approval of the engineer of said Board. Said Board by its engineer or other agent shall be allowed free access at all reasonable times upon the premises of said company to said man-holes or waste water pipes, for the purpose of determining the quantity of waste water, by any such means as said Board shall deem expedient. All the sewage and waste water from the said premises, works and establishments of said company shall be conducted and discharge into said independent sewers and connections to be constructed for that purpose as aforesaid: *provided, however*, that the ordinary sewage and roof water (but not including waste water, as defined in this agreement) from the buildings, shown on the plan hereto annexed, marked "Plan B," and colored red thereon, will continue to be discharged, as at present, into the public sewers of said city.

V.

When said Board shall be of opinion that the metropolitan sewer cannot or should not longer accommodate and receive said waste water, it shall in writing so notify the said company, and to withdraw the waste water from the sewer; and said company shall within six months from the receipt by it of such notice cut off all connection of waste water pipes with the sewers and prevent all waste water from then or at any time thereafter discharging directly, or indirectly through other sewers, into the metropolitan sewer; and if said company shall not so do within said six months, said Board, by its engineer or other agent, may enter at all reasonable times upon the premises of said company and at the outlet points of the waste water pipes cut off all connection of waste water pipes with sewers, and by such means as it may deem

necessary or proper prevent all waste water from then or at any time thereafter discharging directly, or indirectly through other sewers, into the metropolitan sewer; and after the expiration of said six months said company shall take charge of and itself dispose of said waste water, and not cause or allow it to be discharged directly, or indirectly through other sewers, into the metropolitan sewer, or so that it shall in any way ultimately reach the metropolitan sewer, but said sewage shall continue to discharge through said independent connection without charge to said company. Said company shall at all times keep its waste-water pipes distinct from its sewage pipes, until the waste-water pipes shall reach said man-holes, where they are to empty into the sewage pipes. Said company may discontinue the discharge of waste water into the metropolitan sewer by giving to said Metropolitan Sewer Commissioners one month's notice in writing.

VI.

The words "said company," as used in this agreement, refer to the said John P. Squire & Co.

IN WITNESS WHEREOF, the Commonwealth of Massachusetts, by Hosea Kingman, Tilly Haynes and Board of Metropolitan Sewer Commissioners, has hereunto set its name, and the said John P. Squire & Co. has caused its corporate seal to be hereto affixed and these presents to be signed in its name and behalf by Frank O. Squire, its president, and Fred F. Squire, its treasurer, this twenty-eighth day of October in the year eighteen hundred and ninety-six.

(Signed) JOHN P. SQUIRE & CO.,

By (Signed) FRANK O. SQUIRE,

[CORPORATE SEAL.]

President.

(Signed) JOHN P. SQUIRE & CO.,

By (Signed) FRED F. SQUIRE,

Treasurer.

COMMONWEALTH OF MASSACHUSETTS,

By (Signed) HOSEA KINGMAN,

(Signed) TILLY HAYNES,

Metropolitan Sewerage Commissioners.

Witness to H. K., T. H.

(Signed) HERBERT E. BRAYTON.

COMMONWEALTH OF MASSACHUSETTS.

SUFFOLK, ss.

Oct. 28, 1896.

Then personally appeared the above-named Frank O. Squire and Fred F. Squire, and acknowledged the foregoing instrument to be the free act and deed of John P. Squire & Co.

Before me (Signed)

WARD C. MANSFIELD,

Justice of the Peace.

At a meeting of the directors of John P. Squire & Co., duly notified and held at Boston on the twenty-seventh day of October, A.D. 1896, and at which meeting a quorum was present, the foregoing instrument having been read and considered, the following vote was passed:—

Voted, That the president, Frank O. Squire, and the treasurer, Fred F. Squire, are hereby authorized and instructed to sign, seal with the corporate seal, execute and deliver (and that either of said officers is authorized to acknowledge), in the name and behalf of the corporation, the agreement which has just been read, between the Commonwealth of Massachusetts and the corporation.

Attest: (Signed) JOHN P. WYMAN,
 Clerk of John P. Squire & Co.
 By W. L. HILL,
 Clerk pro tem.

In July last bills were rendered the various companies as follows:—

John P. Squire & Co.,	\$217 20
North Packing and Provision Company,	123 44
New England Dressed Meat and Wool Company,	11 95
	<hr/>
	\$352 59

These were paid by check to the Treasurer of the Commonwealth, and by him placed to the credit of the maintenance account of the north metropolitan system.

On May 15, 1897, by vote of the Board, the engineer was authorized to make yearly contracts for sundry small supplies.

FINAL PAYMENT ON PUMPING PLANT.

In our last annual report, page xxiii, we say: "These reservations (\$12,900 in all) due the Allis Company will be payable in April and June, 1897, less any expenses meantime."

The reserve due was approved at said times by the Board and duly paid to the Allis Company.

At its meeting on Sept. 25, 1896, the Board voted to authorize the running of the pumping stations continuously thereafter, and such has been the custom during the past year. The condition of the pumping plant will be found in the report of our chief engineer herewith.

We would especially call to your attention the recommendations contained in said report regarding the purchase of additional pumping machinery for the various stations, to meet the added requirements caused by the increase in the flow of sewage, and recommend that an appropriation be made therefor. The amounts needed are as follows: for a new pump at Deer Island, \$43,000; East Boston, \$44,000; Charlestown, \$46,000; and Alewife Brook pumping station, \$9,500; making a total of \$142,500. These amounts include the placing in position, on foundations which were built as a part of the original construction, of one additional pump and engine with the necessary boilers at each of the pumping stations on this line.

CONNECTIONS WITH THE METROPOLITAN SEWER ON THIS SYSTEM.

At this date (Oct. 1, 1897) one hundred and one connections have been authorized with the metropolitan sewer on this system. These connections have been made during the period covered by the years 1894, 1895, 1896 and 1897, the year in each case ending with October 1, and for the public benefit we publish below a complete list of the connections authorized on this system to date, said list being published by towns in alphabetical order:—

DATE AUTHORIZED.	City or Town.	Location of Connection.	Size.	Date of Completion.
Aug. 24, 1895,	Arlington,	Henderson Street, at Alewife Brook,	10 inch,	Sept. 20, 1895.
May 9, 1896,	Arlington,	At the end of the metropolitan sewer in Decatur Street, . . .	18 inch,	June 20, 1896.
May 1, 1897,	Arlington,	Broadway at Alewife Brook, near town line,	15 inch,	June 19, 1897.
Mar. 2, 1895,	Belmont, . .	Near Hills Crossing,	15 inch,	June 13, 1895.
Aug. 1, 1896,	Boston,* . .	About 200 feet south of shaft at the southerly end of siphon at man-hole in Alford Street, in the park,	15 inch,	Sept. 23, 1896.
Oct. 10, 1896,	Boston,* . .	Navy Yard, on the northerly side of the metropolitan sewer in said yard,	15 inch,	Nov. 1, 1896.
Dec. 5, 1896,	Boston,* . .	On Chelsea Street, opposite Vine Street,	15 inch,	Mar. 2, 1897.
Mar. 27, 1897,	Boston,* . .	Water Street, near Wapping Street,	15 inch,	To be made.

* Charlestown district.

DATE AUTHORIZED.	City or Town.	Location of Connection.	Size.	Date of Completion.
Mar. 27, 1897,	Boston,* . .	Chelsea Street, near Medford Street,	24 inch,	Mar. 30, 1897.
June 19, 1897,	Boston,* . .	Rutherford Avenue, near Dun- stable Street,†	24 inch,	June 25, 1897.
Sept. 14, 1895,	Boston,‡ . .	Orleans and Decatur streets,† . .	16 inch,	Oct. 11, 1895.
Nov. 30, 1895,	Boston,‡ . .	Butler Avenue, Orient Heights, .	12 inch,	Jan. 23, 1896.
May 23, 1896,	Boston,‡ . .	Condor Street, near Meridian Street,	15 inch,	Aug. 14, 1896.
Dec. 12, 1896,	Boston,‡ . .	Border Street, near Decatur Street,†	12 inch,	Feb. 26, 1897.
Nov. 23, 1896,	Boston,‡ . .	At the junction of Bremen and Porter streets,†	18 inch,	Nov. 30, 1896.
Dec. 5, 1896,	Boston,‡ . .	Condor Street, near Meridian Street,	12 inch,	Jan. 26, 1897.
Jan. 19, 1897,	Boston,‡ . .	Border Street, near Eutaw Street,†	12 inch,	Apr. 2, 1897.
Jan. 19, 1897,	Boston,‡ . .	Border Street, near Lexington Street,†	10 feet,	Apr. 27, 1897.
Feb. 13, 1897,	Boston,‡ . .	Butler Avenue, corner Saratoga Street (temporary),	-	-
June 12, 1897,	Boston,‡ . .	New Street, at Sumner Street, .	12 inch,	June 14, 1897.
June 12, 1897,	Boston,‡ . .	House, Bennington Street, near Saratoga Street,	-	-
July 31, 1897,	Boston,‡ . .	Maverick Street, near Jeffries Street,†	12 inch,	July 30, 1897.
July 31, 1897,	Boston,‡ . .	Maverick Street, near Cottage Street,†	12 inch,	Sept. 9, 1897.
Aug. 1, 1896,	Boston,§ . .	About Station 19+20,	8 inch,	Aug. 21, 1896.
Aug. 1, 1896,	Boston,§ . .	Station 12+80,	8 inch,	To be made.
Sept. 18, 1897,	Boston,§ . .	Station 22+80,	8 inch,	To be made.
Oct. 4, 1895,	Cambridge, .	Corner Portland and Binney streets,	48 inch,	Dec. 4, 1894.
May 4, 1895,	Cambridge, .	Mass. Avenue and Alewife Brook,	15 inch,	June 14, 1895.
May 4, 1895,	Cambridge, .	Belmouth Rindge Avenue, for- merly Spruce Street,	15 inch,	June 26, 1895.
May 4, 1895,	Cambridge, .	Concord Avenue,	15 inch,	Aug. 21, 1895.
July 6, 1895,	Cambridge, .	Mt. Auburn and Lowell streets, .	27×28 in.	Aug. 24, 1895.
Aug. 10, 1895,	Cambridge, .	Mt. Auburn Street, corner Wil- lard Street,	12 inch,	Oct. 11, 1895.
Oct. 4, 1895,	Cambridge, .	Near Concord Avenue, for Niles Bros.' slaughtering establish- ment,	8 inch,	Nov. 30, 1895.
Oct. 4, 1895,	Cambridge, .	Mt. Auburn Street, corner Haw- thorn Street,	18 inch,	Dec. 12, 1895.
Mar. 14, 1896,	Cambridge, .	Dunster Street,	12 inch,	June 1, 1896.
Mar. 14, 1896,	Cambridge, .	Corner Dyke and Plympton streets,	30 inch,	June 30, 1896.

* Charlestown district.

† East Boston district.

‡ Connected, but not in operation at this date.

§ Deer Island.

DATE AUTHORIZED.	City or Town.	Location of Connection.	Size.	Date of Completion.
Oct. 19, 1895,	Cambridge, .	Brookline Street, near Cottage Farm station,	10 inch,	Aug. 1, 1896.
July 22, 1896,	Cambridge, .	In private land near Alewife Brook near Mass. Avenue (Tannery Brook connection), . .	15 inch,	Aug. 28, 1896.
Mar. 14, 1896,	Cambridge, .	Pearl Street,	20 inch,	Aug. 31, 1896.
Aug. 10, 1895,	Cambridge, .	North side of Mt. Auburn Street, at Spark Street,	15 inch,	-
Mar. 14, 1896,	Cambridge, .	Waverly and Talbot streets, .	20 inch,	June 24, 1897.
Mar. 14, 1896,	Cambridge, .	Western Avenue,	22 inch,	Nov. 30, 1896.
Mar. 14, 1896,	Cambridge, .	Eliot Square,	15 inch,	Oct. 24, 1896.
Mar. 14, 1896,	Cambridge, .	Pleasant Street,	20 inch,	Oct. 5, 1896.
Oct. 24, 1896,	Chelsea, . .	Second Street, near Cypress Street,	15 inch,	Aug. 24, 1897.
Mar. 13, 1897,	Chelsea, . .	Second Street, near Cypress Street,	6 inch,	May 3, 1897.
June 19, 1897,	Chelsea, . .	Marginal Street, corner Hawthorn Street,	12 inch,	Sept. 9, 1897.
June 19, 1897,	Chelsea, . .	Marginal Street, near Shurtleff Street,	10 inch,	Sept. 8, 1897.
July 3, 1897,	Chelsea, . .	Second Street (temporary only for Metropolitan Water Board),	-	Aug. 24, 1897.
Mar. 24, 1894,	Everett, . .	Under tracks of Boston & Maine Railroad, near East Everett station,	24 inch,	July 3, 1894.
April 20, 1895,	Everett, . .	West Everett, near Faxon's Foundry,	20 inch,	July 10, 1895.
Sept. 18, 1897,	Everett, . .	Second Street (temporary only for Metropolitan Water Board),	-	Sept. 12, 1897.
Nov. 4, 1893,	Malden, . .	Corner Charles and Middlesex streets,	25×38 in.	Jan. 9, 1894.
May 5, 1894,	Malden, . .	Extension of Pearl Street, near boundary line between Malden and Medford,	24 inch,	May 20, 1894.
Aug. 25, 1894,	Malden, . .	Mountain Avenue,	15 inch,	Dec. 17, 1894.
Nov. 3, 1894,	Malden, . .	Medford Street, corner Canal Street,	15 inch,	Mar. 30, 1895.
July 3, 1897,	Malden, . .	Jackson Street (temporary), .	12 inch,	July 24, 1897.
May 26, 1894,	Medford, . .	Riverside Avenue, near to and east of Gravelly Creek, . .	18 inch,	June 18, 1894.
May 26, 1894,	Medford, . .	South side of the metropolitan sewer in Medford Square, .	12 inch,	June 13, 1894.
May 26, 1894,	Medford, . .	Riverside Avenue, junction of Spring Street,	15 inch,	Oct. 19, 1894.
May 26, 1894,	Medford, . .	Riverside Avenue, junction of Park and Marine avenues, .	12 inch,	Nov. 9, 1894.
Aug. 25, 1894,	Medford, . .	In private land at the west end of Canal Street and Boston Avenue,	12 inch,	Sept. 12, 1894.
Aug. 25, 1894,	Medford, . .	Corner of Prospect and Cottage streets,	12 inch,	Sept. 14, 1894.

DATE AUTHORIZED.	City or Town.	Location of Connection.	Size.	Date of Completion.
Aug. 25, 1894,	Medford, . .	In private land, about 460 feet from the corner of Winthrop and High streets,	12 inch,	Nov. 20, 1894.
July 6, 1895,	Medford, . .	Junction Middlesex Avenue and Third Street, Wellington dis- trict,	15 inch,	July 16, 1895.
July 6, 1895,	Medford, . .	Craddock Avenue, Wellington district,	12 inch,	Sept. 18, 1895.
Sept. 7, 1895,	Medford, . .	Mystic Avenue, at end of Section 35,	20 inch,	Jan. 6, 1896.
Sept. 7, 1895,	Medford, . .	High Street, rear of St. Joseph's Church,	10 inch,	To be made.
July 1, 1896,	Medford, . .	Boston Avenue,	8 inch,	July 23, 1896.
July 22, 1896,	Medford, . .	Jerome Street, West Medford, .	12 inch,	Oct. 29, 1896.
April 17, 1897,	Medford, . .	House of R. T. Howes, Prescott Street, near Mystic Street (tem- porary),	6 inch,	May 17, 1897.
April 17, 1897,	Medford, . .	Houses of Fuller and Forest, at a point about 200 feet west of Bradbury Avenue (temporary),	6 inch,	May 17, 1897.
May 15, 1897,	Medford, . .	At west end of Madison Street, .	15 inch,	July 17, 1897.
May 29, 1897,	Medford, . .	Riverside Avenue, opposite Lo- cust Street,	15 inch,	June 26, 1897.
July 21, 1894,	Melrose, . .	Corner Wyoming Avenue and Pleasant Street,	20 inch,	Dec. 15, 1894.
Sept. 5, 1896,	Melrose, . .	Corner Gould and Pleasant streets,	15 inch,	Sept. 25, 1896.
Sept. 5, 1896,	Melrose, . .	Corner Gilbert and Pleasant streets,	12 inch,	Oct. 5, 1896.
May 29, 1897,	Melrose, . .	House 45 Myrtle Street (tem- porary),	5 inch,	May 19, 1897.
Dec. 19, 1896,	Melrose, . .	At Station 29+05 Essex Street, .	5 inch,	Dec. 21, 1896.
May 1, 1897,	Melrose, . .	Myrtle Street, about 210 feet north of Foster Street, . . .	5 inch,	May 11, 1897.
May 29, 1897,	Melrose, . .	House 23 Grove Street, west of man-hole at Myrtle Street, . .	5 inch,	May 19, 1897.
May 29, 1897,	Melrose, . .	House 19 Grove Street, near man- hole at Mystic Street, . . .	5 inch,	May 19, 1897.
Nov. 9, 1895,	Somerville, .	On Mystic Avenue, at Moreland Street,	12 inch,	Mar. 21, 1896.
April 25, 1896,	Somerville, .	Corner Mystic and Winthrop avenues,	30 inch,	May 29, 1896.
May 16, 1896,	Somerville, .	Corner Rowland and Waverly streets,	24 inch,	July 21, 1896.
Sept. 19, 1896,	Somerville, .	Corner Somerville Avenue and Poplar Street,	48 inch,	Oct. 20, 1896.
June 22, 1895,	Winchester, .	Corner Main and Church streets,	10 inch,	Feb. 27, 1895.
June 22, 1895,	Winchester, .	Common Street,	10 inch,	Feb. 27, 1895.
June 22, 1895,	Winchester, .	Rear of freight sheds, Boston & Maine Railroad,	15 inch,	Mar. 21, 1895.
Jan. 26, 1895,	Winchester, .	Near siphon at Mystic station at Abajona River,	10 inch,	July 21, 1895.

DATE AUTHORIZED.	City or Town.	Location of Connection.	Size.	Date of Completion.
Jan. 26, 1895,	Winchester, .	Old Mystic valley sewer, near Abbajona River,	10 inch,	Aug. 8, 1895.
-	-	Turned the old Mystic valley sewer into the metropolitan sewer,	-	July 18, 1895.
Oct. 3, 1896,	Winchester, .	Easterly side of metropolitan sewer in Cross Street,	12 inch,	Oct. 17, 1896.
Nov. 30, 1895,	Winchester, .	275 feet south of Swanton Street, Station 5+11.20, Section 45, . .	15 inch,	Dec. 21, 1895.
Aug. 1, 1896,	Winchester, .	On westerly side of metropolitan sewer in Mystic valley park- way, at man-hole,	18 inch,	Aug. 25, 1896.
Jan. 27, 1894,	Winthrop, .	Shirley Street, corner Washing- ton Avenue,	12 inch,	Jan. 17, 1895.
July 6, 1895,	Winthrop, .	Pleasant Street, near Belle Isle Inlet,	12 inch,	Aug. 24, 1895.
Oct. 12, 1895,	Winthrop, .	Shirley Street, Short Beach, . .	10 inch,	Oct. 29, 1895.
July 22, 1896,	Winthrop, .	At Magee's Corner,	12 inch,	Oct. 8, 1896.
May 25, 1895,	Woburn, . .	Corner Canal and Lake streets, .	15 inch,	Oct. 9, 1895.
Sept. 7, 1895,	Woburn, . .	In private land, Baeder, Adamson & Co., glue works settling tanks,	8 inch,	Nov. 9, 1895.
July 6, 1895,	Woburn, . .	Old Mystic valley sewer, at Cross Street,	15 inch,	Sept. 2, 1895.

The one hundred and one connections authorized on this system to this date (Oct. 1, 1897) are distributed as follows: Arlington, three; Belmont, one; Boston (Charlestown district), six; Boston (East Boston district), thirteen; Boston (Deer Island), three; Cambridge, eighteen; Chelsea, five; Everett, three; Malden, five; Medford, seventeen; Melrose, eight; Somerville, four; Winchester, eight; Winthrop, four; and Woburn, three. Included within these one hundred and one connections, four remain to be made, one in Charlestown, two at Deer Island and one in Medford; while nine are connected, though not in operation, eight of these being in East Boston and one in Charlestown, thus leaving eighty-eight connections in actual operation at this time (Oct. 1, 1897).

EXPENDITURES.

The expenditures upon this system, including all payments on account of contracts during the twelve months ending Sept. 30, 1897, amount to \$44,260.79. This, with the amount previously reported, \$4,956,554.50, makes the total

expenditures on this system proper \$5,000,815.29 to date. There has also been expended during the year upon the Wakefield branch \$24,961.59, which, in addition to the amount previously reported, \$125.98, makes \$25,087.57; upon the Stoneham branch, \$2,802.68; making a grand total on this system and its branches to date, \$5,028,705.54. Table D in the Appendix contains a full statement of the cost of operation for the year ending Sept. 30, 1897. Your attention is called to the tables submitted herewith for matters of detail.

CHARLES RIVER VALLEY SYSTEM.

This system has been in constant operation during the year, and a full statement of the expense thereof is in Table E of the Appendix. The negotiations which were pending between the city of Boston and the State providing for receiving into the main trunk sewer of said city at Huntington Avenue, corner of Gainsborough Street, Boston, the sewage from this system, and discharging the same at its outlet at Moon Island, for the period of five years, 1896 to 1900 inclusive, have been continued but without definite result at this date (Oct. 1, 1897). There seems, however, a possibility of a conclusion being reached and proper agreements being entered into between this Board and said city before the close of this year, as under the provisions of chapter 502, Acts of 1897, approved June 10, 1897, the city of Boston has asked for further negotiations regarding the same. Said agreement will also include the reception and disposal of the sewage from the Neponset valley system, covering the same period. Pending such contract, under verbal arrangement, the State has paid said city at the rate of \$27,000 per annum in quarterly instalments for the years 1896 and 1897, for such reception and disposal of the sewage from this system. A bill prepared for the committee on metropolitan affairs of the Legislature of 1896, and by said Legislature referred to its successor, authorizing the Commonwealth to acquire the Boston main drainage system, by purchase or otherwise, and making appropriation therefor, we would respectfully call to your attention, and again urge its passage.

But one settlement for land taken upon this system has been made during the year. On the 16th of June, 1897, Charles A. Read, an owner of land in Newton, quit-claimed to the Commonwealth, by deed of even date, "rights, privileges and easements" included within a taking made by this Board dated March 7, 1891, and recorded with Middlesex South District Deeds, book 2030, page 121. The deed of Read is recorded in said Registry, book 2583, page 76.

This leaves the following cases on this system still pending in court at this date (Oct. 1, 1897): Suffolk County, Butchers' Slaughtering and Melting Association, motion for a new trial still pending; Middlesex County, Albert Brackett, Newton.

WATERTOWN SIPHON.

In our last report (Public Document No. 45, 1897) we say: "The engineer was authorized to proceed with the work of constructing the siphon at East Watertown upon receipt of licenses from the authorities in Washington, D. C., and the Harbor and Land Commissioners of the Commonwealth, which have not been received at this date (Oct. 1, 1896)."

The license from the authorities in Washington, D. C., was received on the 17th of October, 1896, that from the Harbor and Land Commissioners of the Commonwealth having previously reached this Board; and on Oct. 28, 1896, a contract was executed with Perkins & White of Boston for the construction of said siphon, at an expense of \$8,000, all expense attending said construction to be paid by the town of Watertown.

An easement in certain parcels of land in Brighton and Watertown necessary for the construction of said siphon was taken by this Board by two deeds dated Oct. 17, 1896, and recorded, that for Brighton in Suffolk Registry of Deeds, book 2394, page 530; that for Watertown with Middlesex South District Deeds, book 2506, page 148. On May 22, 1897, the chief engineer presented to the Board the certificate of completion of the Watertown siphon by Perkins & White, contractors, and the same was accepted by vote of the Board.

On June 26, 1897, in answer to a petition, the Board approved a connection for said town by means of an 18-inch

branch with this siphon. This is the only connection made with the metropolitan sewer in the Charles River valley during the year ending Sept. 30, 1897, and makes a total of thirty-nine connections authorized on this system to date. We print a complete list thereof according to localities:—

DATE AUTHORIZED.	City or Town.	Location of Connection.	Size.	Date of Completion.
May 3, 1892,	Boston,* . .	Cambridge Street, corner Seattle Street,	15 inch,	May 3, 1892.
May 6, 1892,	Boston,* . .	Rena Street,	12 inch,	May 6, 1892.
Sept. 27, 1892,	Boston,* . .	Western Avenue, foot of Market Street,	18 inch,	Sept. 27, 1892.
Oct. 28, 1892,	Boston,* . .	Western Avenue, near Everett Street,	24 inch,	Oct. 28, 1892.
Jan. 27, 1893,	Boston,* . .	Near Salt Creek,	24 inch,	Jan. 27, 1893.
May 2, 1893,	Boston,* . .	Near Parsons' Brook,	24 inch,	May 2, 1893.
July 1, 1893,	Boston,* . .	Near Faneuil station,	15 inch,	July 1, 1893.
July 12, 1893,	Boston,* . .	Rena Street, corner Bertram Street,	15 inch,	Aug. 25, 1893.
Aug. 19, 1893,	Boston,* . .	Abbattoir, Station 24+08,	15 inch,	Sept. 26, 1893.
Aug. 19, 1893,	Boston,* . .	Abbattoir, Station 34+63,	15 inch,	Oct. 6, 1893.
Sept. 9, 1893,	Boston,* . .	Abbattoir (tripe works),	15 inch,	Oct. 26, 1893.
May 12, 1894,	Boston,* . .	Parsons Street, opposite Taylor's Mill,	24 inch,	July 31, 1894.
Nov. 17, 1894,	Boston,* . .	Corner North Harvard and Spurr streets,	15 inch,	Nov. 20, 1894.
May 24, 1892,	Boston, . .	Brookline Avenue, corner Bellevue Street,	12 inch,	May 24, 1892.
May 30, 1892,	Boston, . .	133 feet north of Brookline Avenue, Back Bay Pews,	6 inch,	May 12, 1893.
May 19, 1894,	Boston, . .	Huntington Avenue, near Parker Street,	12 inch,	May 30, 1894.
Oct. 13, 1892,	Boston, . .	Commonwealth Avenue and St. Mary Street,	18 inch,	Oct. 13, 1892.
Feb. 3, 1893,	Boston, . .	Vila Street,	24 inch,	Feb. 3, 1893.
May 12, 1893,	Boston, . .	Park Commissioners, Administration Building,	6 inch,	May 12, 1893.
May 19, 1894,	Boston, . .	Huntington Avenue and Parker Street,	12 inch,	May 30, 1894.
July 20, 1895,	Boston, . .	Corner Huntington Avenue and Bryant Street, on south side of metropolitan sewer,	24 inch,	Sept. 19, 1895.
July 20, 1895,	Boston, . .	Corner Huntington Avenue and Bryant Street, on north side of metropolitan sewer,	12 inch,	Sept. 26, 1895.
April 29, 1892,	Brookline, . .	Commonwealth Avenue, corner St. Mary Street,	24 inch,	Apr. 29, 1892.
May 3, 1892,	Newton, . .	At Lemon or Hyde Brook,	24 inch,	May 3, 1892.

* Brighton.

DATE AUTHORIZED.	City or Town.	Location of Connection.	Size.	Date of Completion.
May 4, 1892,	Newton, . .	California Street, corner Crescent Street,	24 inch,	May 4, 1892.
May 28, 1892,	Newton, . .	Nonantum Street,	10 inch,	May 28, 1892.
Oct. 8, 1892,	Newton, . .	Near Cheesecake Brook,	24×36 in.	Oct. 8, 1892.
May 11, 1893,	Newton, . .	California and Said streets,	10 inch,	May 11, 1893.
Sept. 1, 1893,	Newton, . .	California and Dalby streets,	10 inch,	Sept. 1, 1893.
Oct. 26, 1895,	Newton, . .	In garden of Sarah L. M. Bates, near Hyde Brook,	5 inch,	Nov. 4, 1895.
May 2, 1896,	Newton, . .	In land of estate of Matilda Emerson, east of Hyde Brook,	5 inch,	May 18, 1896.
June 24, 1892,	Waltham, . .	Corner North and Calvary streets, at the end of the metropolitan sewer,	-	June 24, 1892.
June 9, 1892,	Watertown, . .	California Street, corner Galen Street,	24 inch,	June 9, 1892.
July 9, 1892,	Watertown, . .	Watertown Street, corner California Street,	10 inch,	July 9, 1892.
July 9, 1892,	Watertown, . .	Water Street, on the east side of the metropolitan sewer,	8 inch,	July 9, 1892.
July 9, 1892,	Watertown, . .	Water Street, on the west side of the metropolitan sewer,	8 inch,	July 9, 1892.
May 26, 1893,	Watertown, . .	Barker's Starch Factory,	6 inch,	May 26, 1893.
July 1, 1893,	Watertown, . .	Hickory Wheel Company,	5 inch,	Never connected.
June 26, 1897,	Watertown, . .	At siphon at U. S. Arsenal,	18 inch,	July 21, 1897.

These thirty-nine connections authorized to this date (Oct. 1, 1897) are distributed as follows: Boston (Brighton district), thirteen; Boston, nine; Brookline, one; Newton, eight; Waltham, one; and Watertown, seven. One of these (the Hickory Wheel Company, Watertown) has never been made, and is not likely to be, the said company having moved from Watertown outside the metropolitan district.

EXPENDITURES.

The expenditures upon this system, including all payments on account of contracts during the twelve months ending Sept. 30, 1897, but not including expenses of operations (which are particularly stated in Table E of the Appendix), amount to \$325.21. This, with the amount previously reported, \$788,797.31, makes \$789,122.52 as the total expenditures to date.

Your attention is called to tables submitted herewith for matters of detail, and especially to Table E, “for maintaining and operating the Charles River valley system.” The third item in said table, dated “Feb. 11, 1897, to appropriation made by chapter 61, Acts of 1897, \$1,857.07,” is explained by the following correspondence:—

COMMONWEALTH OF MASSACHUSETTS.

METROPOLITAN SEWERAGE COMMISSIONERS, 1 MT. VERNON ST.,
BOSTON, Jan. 9, 1897.

Hon. JOHN W. KIMBALL, *Auditor, Commonwealth of Massachusetts,
State House, Boston, Mass.*

DEAR SIR:—I send herewith bill and vouchers, amounting to \$384.67, for money paid on account of maintaining and operating the Charles River valley system of sewerage, and when this shall have been allowed and paid there will remain unexpended \$4,892.93 of the amount heretofore appropriated for this purpose. There remains unpaid at this date (Jan. 9, 1897), a bill of the city of Boston (enclosed herewith) amounting to \$6,750, for disposing of the sewage from said valley for the quarter ending Jan. 1, 1897, which is more by \$1,857.07 than the amount on hand to pay the same. The reason for this deficiency is principally our failure to make as favorable terms with the city for the year 1896 as we had in previous years. No contract was made until April, 1896, and then only a verbal one, covering that year, for \$27,000, particulars of which are fully given in the eighth annual report, pages xxvi to xlii, inclusive (Public Document No. 45, 1897). This was \$3,000 in excess of the highest amount previously paid, and greater than the amount used in making the estimate reported to the Legislature of 1896.

Will you kindly present this matter to the General Court at its present session, in accordance with the provisions of section 37, chapter 16 of the Public Statutes, that the deficiency may be provided for?

By order of the Board, (Signed) EDWARD P. FISK,
Clerk.

The Auditor, as requested, included in a deficiency bill (chapter 61, Acts of 1897) \$1,857 07.

This Board had intended to include in this report two maps, both similar to that published in our last annual report (Public Document No. 45, 1897), one showing more clearly by different colors the areas in the three systems contribut-

ing a compound system, *i.e.*, where storm water and house sewage contribute to the sewer, and also where storm water is eliminated from the system; and the other showing the proposed high-level sewer recommended by the chief engineer in his communication to the Board, dated Aug. 24, 1897, discharging at Peddock's Island. In accordance with the provisions of chapter 258 of the Acts of 1896 the following correspondence, which explains itself, was had:—

METROPOLITAN SEWERAGE COMMISSION, 1 MT. VERNON ST.,
BOSTON, Oct. 29, 1897.

Hon. WILLIAM M. OLIN, *Secretary of State, State House, Boston.*

DEAR SIR:—In preparing the ninth annual report of the Metropolitan Sewerage Commissioners, it is desired to introduce two maps of the metropolitan sewerage district. The first of these maps shows in a general way the routes of the sewers, sizes and elevations, and the territory provided for and now connected with the system. The stones for this general map were prepared and paid for last year. The map as at present prepared involves the printing of two more colors than appeared last year. The price of last year's printing, not including stone, was \$185. The lithographers, Messrs. Geo. H. Walker & Co., who now hold the stone, are asking for this year's print of the map \$185, as last year, plus \$50 for the additional colors, making a total cost of \$235 for an issue of 3,000 copies.

The second map which it is desired to introduce shows the general district, and a study of a contemplated future high-level sewer, about which certain recommendations are to be made by the Metropolitan Sewerage Commissioners. This map will involve a reproduction of the original map and a printing of seven colors, three more than on the original map. For this map the lithographers ask \$185, same as original, plus \$75 for three extra colors, making a total cost of \$260 for 3,000 copies.

If an order is given for both maps, the lithographer will furnish both for \$465, as parts of the printing on both stones can be made with one set of the printing press.

In addition to the maps above outlined, it is desired to produce two zinc plates, showing anticipated quantities of sewage, for the purpose of contrasting them with actual quantities received at the pumping stations. Wright & Potter, printers, will furnish these zinc plates for \$7, and they can be printed with the regular text.

In accordance with chapter 258 of the Acts of 1896 we now make application to you to authorize this work, in order that we

may begin on the maps to finish them at such a time as will avoid delay in the publication of our report.

A copy of this request has been forwarded to General Kimball, the Auditor.

For the Board, yours very truly,

(Signed)

HERBERT E. BRAYTON,

Acting Clerk.

A similar communication of even date was addressed to the Auditor of the Commonwealth, and the following reply was received : —

COMMONWEALTH OF MASSACHUSETTS,
OFFICE OF THE SECRETARY, BOSTON, NOV. 3, 1897.

HERBERT E. BRAYTON, *Acting Clerk, Metropolitan Sewerage Commissioners, 1 Mt. Vernon Street, Boston.*

DEAR SIR : — Referring to yours of October 29, relative to proposed illustration of the ninth annual report of the Metropolitan Sewerage Commissioners, at an aggregate cost of \$472, the Secretary of the Commonwealth and the Auditor of Accounts desire to be informed as to what will be shown by the addition of the two colors to the map of last year more than was shown on that map ; also, whether the lithographic stone is the property of Messrs. George H. Walker & Co., or of the Commonwealth.

An early reply is requested.

Very respectfully,

(Signed)

WM. M. OLIN,

Secretary.

The clerk and chief engineer of the Board waited upon the Secretary and Auditor and furnished them the information desired, after which the following was received in reply : —

COMMONWEALTH OF MASSACHUSETTS,
OFFICE OF THE SECRETARY, BOSTON, NOV. 16, 1897.

EDWARD P. FISK, Esq., *Clerk, Metropolitan Sewerage Commissioners, 1 Mt. Vernon Street, Boston.*

MY DEAR SIR : — Referring to the request of the Metropolitan Sewerage Commissioners for authority to illustrate the forthcoming annual report of the commissioners by certain maps and plates at a total expense of \$472, I beg to say that, as the appropriation from which the cost of these illustrations must be paid is exhausted, the Secretary of the Commonwealth and the Auditor of Accounts find themselves, much to their regret, unable to grant the desired authority.

Very respectfully,

(Signed)

WM. M. OLIN,

Secretary.

We publish herewith the full report of the chief engineer on the high-level sewer alluded to, as it affects both the Charles River and Neponset valley systems : —

BOSTON, MASS., Aug. 24, 1897.

HOSEA KINGMAN, TILLY HAYNES, GEORGE A. KIMBALL, *Board of Metropolitan Sewerage Commissioners.*

GENTLEMEN : — In compliance with your request, preliminary studies have been prepared of probable cost of sewage disposal for the Charles and Neponset River areas of the metropolitan sewerage system by other means than through the main sewers and pumping station of the main drainage works of the city of Boston. The results of these studies are herewith submitted.

The total area at present tributary to the main drainage works is approximately 121 square miles, divided as follows : —

City of Boston (square miles),	23
City of Quincy (square miles),	12
Charles and Neponset areas of metropolitan sewerage (square miles),	86

This is approximately 100 per cent. in excess of the area for which the works were originally designed. The excess is made up by the addition of the following cities and towns to the area as originally outlined : Waltham, Watertown, Dedham (nearly the whole of the town, including the main village), Hyde Park, Milton and Quincy.

The very large added areas and the increase of population, much in advance of the original estimates, have so materially reduced the life of the works that the ultimate capacity will probably be attained about A.D. 1910, or from ten to fifteen years earlier than anticipated in the original studies. This fact is further outlined in the seventh annual report of your Board, pages 44 and 45.

Of the area now tributary to main drainage, 61 square miles, or about 50 per cent. of the tributary area, is at sufficient elevation and suitably located to collect its sewage in a gravity sewer, outletting at Moon Island or elsewhere on the coast. Such a high-level interceptor was contemplated in the original design of main drainage, and a branch 9 feet in diameter was built into the main sewer at Squantum in anticipation of it.

The necessities of the Neponset valley will probably require the construction of a high-level relief sewer to Hyde Park as early as A.D. 1905, as outlined in the seventh annual report of your Board, pages 42 to 46 inclusive. As the Moon Island outlet could provide for it for only five or ten years, it would appear desirable

to construct a new outlet at Nut Island, Peddock's Island or elsewhere. The probable route of such a high-level sewer when built above Hyde Park could pass within a short distance of the lower end of the Charles River main. A practical and comparatively inexpensive scheme would be to sufficiently enlarge this high-level sewer when built, and receive sewage from the Charles River area lifted to it about 45 feet by pumps located near the lower end of the Charles River system.

On the accompanying map* are outlined, in brown, areas naturally tributary to such a high-level sewer; areas in the Charles River valley and lower Neponset and Quincy requiring to be pumped are outlined in blue.

Quincy is already preparing to pump all its sewage about 30 feet to Squantum; to the high-level sewer, as shown, drainage from only the lower areas will need to be lifted about 20 feet, while the higher parts of the city can drain into it by gravity.

Preliminary estimates of cost from the best available data have been prepared for a high-level sewer over the routes indicated on the map to Moon Island, Nut Island and Peddock's Island, with and without enlargement sufficient to receive Charles River sewage. No surveys or geological studies of the ground have been made.

Table of Gross Cost for High-level Sewer, as shown on Accompanying Maps, from Corner of Boylston and Cypress Streets in Brookline to Outlet at Coast, including Pumping Stations and Force Mains in Charles and Neponset River Areas, not including Cost of Pumping Station and Force Main in Quincy.

To Moon Island:—

High-level sewer without Charles River sewage, . . .	\$3,922,296
High-level sewer with Charles River sewage, . . .	4,714,925

To Nut Island:—

High-level sewer without Charles River sewage, . . .	\$3,331,856
High-level sewer with Charles River sewage, . . .	4,202,956

To Peddock's Island:—

High-level sewer without Charles River sewage, . . .	\$3,745,516
High-level sewer with Charles River sewage, . . .	4,618,713

From the foregoing table it appears that about \$900,000 for either of the three routes would be the total cost of enlarging a high-level trunk sewer sufficiently to receive Charles and Neponset area sewage needing to be pumped, and providing pumping stations and force mains from present metropolitan areas outlined in blue.

* See correspondence, pp. xxiv, xxv.

The studies thus far made indicate that by A.D. 1905 a high-level sewer will probably have been constructed. At that date the sewage from about one-fifth of the Neponset and nine-tenths of the Charles River area will require to be pumped.

The expense of disposal for these areas through the high-level system for the decennial period A.D. 1905 to 1915 will be approximately as follows : —

Interest and sinking fund charges, 3½ per cent. on \$900,000, .	\$31,500
For maintenance of Charles River pumping station : —	
Labor,	\$6,000
Coal and supplies,	6,000
	<hr/> 12,000
For maintenance of Granite bridge station : —	
Labor,	\$3,000
Coal and supplies,	2,000
	<hr/> 5,000
Total yearly charges,	<hr/> \$48,500

For disposal through main drainage system by rental for these areas, as outlined in letter of B. W. Wells of Jan. 23, 1896, for A.D. 1905 to A.D. 1910, is —

1905,	\$65,300
1910,	74,600

averaging for the period \$69,900.

The conclusions from the study are as follows : the capacity of Boston's present outlet at Moon Island is so rapidly being taken up by the sewage from the very largely extended areas now tributary to it, that when the high-level gravity sewer is built it will probably be found wisest to seek a new outlet for it at the coast ; that the necessities of the Neponset valley will require this high-level sewer about A.D. 1905 ; that when built it can be slightly enlarged to receive through pumps the Charles River sewage at reasonable and practicable costs, and with economy, above rental at present demanded by the city of Boston.

To determine the most desirable location for a new outlet at the coast for a high-level system would require careful hydrographic surveys extended over a year or more. Much of the sewerage of Milton is possibly dependent on the route of a future high-level sewer through that town. In Hyde Park and the southerly section of Stony Brook area of the city of Boston definite knowledge is already needed of the future high-level route, to enable engineers to prepare studies of sewage relief for these areas. The State Board of Health has practically prohibited overflows from your

Neponset valley system, which will necessitate an additional relief outlet at an early date.

It would seem desirable to arrange, if possible, for a comprehensive study of the future high-level problem. It might offer a solution of the question of future rentals to the city of Boston. Profiles and detailed estimates of routes indicated accompany the general map.

Respectfully submitted,

(Signed) WM. M. BROWN, Jr.,
Chief Engineer.

We would respectfully recommend that an amount, which can be reported later, be made to make the necessary soundings, float experiments and borings to determine the best course for the high-level sewer, and ask that said appropriation be made as early as possible, so that the work may be carried out without unnecessary delay.

NEPONSET VALLEY SYSTEM.

The following settlements for land taken upon this system have been made during the year : —

On Nov. 24, 1896, Thomas F. Reddy released to the Commonwealth “rights, privileges and easements” in land in Hyde Park, included within a taking dated April 25, 1896, and recorded with Norfolk Deeds, book 759, page 601. The deed of Reddy’s is recorded with Norfolk Deeds, book 776, page 637.

On Feb. 12, 1897, the Tileston & Hollingsworth Company of Boston, by deed recorded with Suffolk Registry, book 2423, page 439, quit-claims to the Commonwealth “rights, privileges and easements” in certain parcels of land in Boston (Dorchester), included within a taking dated March 28, 1896, and recorded with Suffolk Deeds, book 2347, page 585; and on Jan. 14, 1897, John W. Smith of Hyde Park conveyed to the Commonwealth in fee a parcel of land in said Hyde Park, for use as a stock yard and locker. Said deed of Smith’s is recorded with Norfolk Registry, book 776, page 636.

On Feb. 10, 1897, Martha A. Marshall, John O. Ray and Sarah M. Ray, his wife, by deed recorded with Norfolk Registry, book 787, page 512, quit-claimed to the Commonwealth "rights, privileges and easements" in land in Hyde Park included within a taking dated June 13, 1896, and recorded with Norfolk Registry, book 764, page 5; Ernest Halbauer of Dedham, with Sarah Halbauer, his wife, and the Dedham Institution for Savings, holder of a certain mortgage on said premises, release to the Commonwealth "rights, privileges and easements" included within the former taking and recorded as aforesaid. This deed of Halbauer's is recorded with Norfolk Registry, book 787, page 510.

Lucy B. Fitton of Hyde Park, by deed dated March 13, 1897, together with the Hyde Park Savings Bank, the holder of a certain mortgage on said premises, quit-claims to the Commonwealth "rights, privileges and easements" in land in Hyde Park, included within a taking dated April 25, 1896, and recorded with Norfolk Registry, book 759, page 601. The deed of Fitton's is recorded with Norfolk Registry, book 787, page 509.

By deed dated April 16, 1897, recorded with Suffolk Registry, book 2448, page 4, Edward Cushing and Mary Cushing, his wife, release to the Commonwealth "rights, privileges and easements" in land in Boston (Dorchester), included within a taking dated March 28, 1896, and recorded with Suffolk Registry, book 2347, page 385.

Abba M. Martine, in her own right, and Charles F., her husband, with Albert K. Teele and Richard C. Humphreys, executors and trustees under the will of Edmund J. Baker, the assignee of a mortgage given by said Martines, release to the Commonwealth "rights, privileges and easements" in a certain parcel of land in Boston (Dorchester), included within the aforesaid taking. The said deed from Martine is recorded with Suffolk Registry, book 2448, page 1.

Two other deeds for damage to land included within the aforesaid taking have been executed. John B. Tileston, Roger E. and Wilder Tileston, together with John B. Tileston and Arthur Foote, trustees under the will of Caleb Foote, the assignees of a certain mortgage given by Franklin L. Tileston, by deed dated April 17, 1897, quit-claim to the

Commonwealth “rights, privileges and easements” in land in Boston (Dorchester); and John Conness, with Mary R., his wife, together with the Franklin Savings Bank of Boston, holder of a certain mortgage given by said Conness, quit-claim to the Commonwealth by deed dated July 19, 1897, “rights, privileges and easements” in land in Boston (Dorchester), included within the aforesaid taking. The deed from the Tilestons is recorded in Suffolk Registry, book 2448, page 3; and that from John Conness in Suffolk Registry, book 2464, page 94.

Eva J. Dolliver of Kingston, N. H., by deed dated Sept. 3, 1897, quit-claims to the Commonwealth “rights, privileges and easements” in land in Hyde Park, included within a taking made April 25, 1896, and recorded with Norfolk Registry, book 759, page 601. Her deed is recorded in Norfolk Registry, book 798, page 13.

“Rights, privileges and easements” in land included within a taking made by this Board June 13, 1896, and recorded in Norfolk Registry, book 764, page 5, were released to the Commonwealth in land in Dedham by Thomas F. Temperly of said Dedham and Catherine Temperly, his wife, in her own right, by deed dated July 21, 1897, and recorded in Norfolk Registry, book 794, page 221. Another deed, dated July 21, 1897, from William J. Mulkern of Dedham and Nellie V., his wife, in her own right, releases to the Commonwealth land in Dedham in the aforesaid taking, which deed is recorded in Norfolk Registry, book 794, page 226, and is joined in by Jonathan M. Smith, assignee of a mortgage given to Benj. Smith by Artemas S. Raymond, and dated June 17, 1874.

Similar “rights, privileges and easements,” included within a taking dated July 1, 1896, and recorded in Norfolk Registry, book 764, page 501, have been released to the Commonwealth by deeds as follows: dated June 18, 1897, Elijah W. Bonnemort and Cora E., his wife, by deed recorded in Norfolk Registry, book 794, page 222; Peter Gallagher of Dedham, with Mary, his wife, by deed dated July 29, 1897, and recorded in Norfolk Registry, book 794, page 223; Chauncey S. Churchill, John Monahan, with Elizabeth, his wife, by deed recorded with Norfolk Registry, book 794, page 259;

Isabel Chisholm, by deed dated Aug. 7, 1897, recorded in Norfolk Registry, book 794, page 224; Bernard McCaffrey, by deed dated Aug. 9, 1897, recorded with Norfolk Registry, book 794, page 225; Ruth Proctor, by deed dated Sept. 27, 1897, recorded with Norfolk Registry, book 798, page 14. The rights in land conveyed by the last six deeds all lie in the town of Dedham.

On Jan. 23, 1897, the Engineer was authorized to expend \$150 for a locker and fence surrounding the yard on the lot purchased in Hyde Park of John W. Smith, and the same has since been done.

On May 1, 1897, the Board voted to advertise for bids on the remaining sections (26 to 29) on the Neponset valley system, to be opened at noon of May 22, 1897. On that date, from the eleven bids on Section 26 and nine on Section 27, the Board accepted the bid of the National Contracting Company of New York, the lowest bidders on each section, fixing the bonds on the same at \$5,000 on Section 26 and \$3,600 on Section 27. These bonds were furnished by the National Contracting Company of New York, with the American Surety Company of New York as surety, and duly accepted by the Board, contracts being executed with them for the construction of Sections 26 and 27.

Sections 28 and 29 were taken under advisement by the Board, and at the meeting of May 29, 1897, the Board allowed T. F. Lynch & Co. to withdraw their bid on Section 28. Burton R. Felton of Somerville, Frederick Holbrook of Quincy, William B. Cabot of Brookline and John W. Daly of Boston, under the firm name of Felton & Holbrook, Cabot & Daly, offered to take this section at the figures submitted by T. F. Lynch & Co. The Board placed the bond for the same at \$4,000, but postponed action in awarding the contract for one week, to await result in regard to taking on said section. On the same date the Board accepted the bid of Dennis F. O'Connell of Dorchester for the construction of Section 29, fixing the bond on the same at \$2,700. At the meeting of June 5, 1897, the bonds on these sections were furnished by the contractors, that on Section 28 with the American Surety Company of New York as surety, and that on Section 29 with Thomas W.

Carter and Mary F. O'Connell, both of Boston, as sureties ; and said contracts were executed by the Board. These sections complete the full line of the Neponset valley system.

A full list of the bids received on these four sections will be found in Table B of the Appendix.

LAND TAKINGS.

The land takings of the Board during the past year upon this system have been as follows, and are mainly on the four sections for which contracts have been made : on May 29, 1897, the Board executed a deed taking the right to construct, operate and maintain an underground main sewer, beginning at the point forming the terminus of the taking dated July 1, 1896, and recorded with Norfolk Deeds, book 764, page 501, and extending from that point to the boundary line between West Roxbury and Dedham. This deed is recorded with Norfolk Registry, book 787, page 502.

The taking in West Roxbury is made by three deeds, executed June 5, 1897, plans marked Numbers 1, 2 and 3, respectively, and recorded with Norfolk Registry, book 2448, pages 6 to 14, inclusive.

LOCATION OF SEWER LINE.

The centre line of sewer on these sections may be described as follows : beginning at the point reached by the taking of July 1, 1896, between land of Elijah Bonnemort and Mary E. Nay, about 350 feet beyond the point where the sewer crosses the Dedham branch of the New York, New Haven & Hartford Railroad, the centre line continues through private lands to the boundary line between Dedham and West Roxbury, and thence crossing the said boundary line it continues in private lands to Gardner Street ; thence it follows said street to private lands near the corner of Adams Street, and passes through other private lands from this point, crossing Farragut Street and private lands to Baker Street ; crossing said street, it continues through private lands to LaGrange Street, and thence by LaGrange, Weld and Newfield streets to private lands, crossing Caspar Street, and other private lands belonging to Mary C. Blakemore. Here it crosses

Worley Street and private lands to Weld Street, continuing on said street to a point about 300 feet from where a brook crosses said street in the neighborhood of Gould Avenue.

The total length of this line is 16,806 feet, of which 14,219 feet lie in private land and 2,587 feet in public highways. This, added to the amount reported in our last annual report (Public Document No. 45, 1897, page lix), makes 52,462 feet as the length of the sewer in the Neponset valley, of which 34,460 feet is in private land and 18,002 feet in public highways.

At the meeting of Jan. 2, 1897, Ellerton P. Whitney, chairman, and other members of the Board of Sewer Commissioners of Milton, met this Board by appointment, and asked that outlets for said town be provided at the following points: on the Milton side of the river in said town, at Granite bridge, Milton Lower Mills, Central Avenue and Mattapan. They were advised to secure legislation authorizing the same, which they did by chapter 80, Acts of 1897, approved February 18 of that year; and in accordance with this act the Board, at its meeting of June 5, directed the Engineer to proceed with the construction of the Milton connections by day labor, having voted at its meeting of May 29, 1897, to execute takings of land for these connections, with the exception of Granite bridge. The deeds of these takings are recorded with Norfolk Registry, book 787, pages 504 to 507 inclusive, and in Suffolk Registry, book 2446, pages 449 to 453 inclusive. The plans of the connections received the approval of the Harbor and Land Commissioners, and were submitted to the State Board of Health in accordance with the provisions of the act; the following reply being received from the latter Board:—

OFFICE OF STATE BOARD OF HEALTH,
STATE HOUSE, BOSTON, May 28, 1897.

To the Metropolitan Sewerage Commission, Boston, Mass.

GENTLEMEN:—The State Board of Health received from you, on April 24, 1897, an application requesting the approval of plans for extensions of the Neponset valley sewer to the town of Milton, the approval of the Board being required by the provisions of section 1, chapter 406, Acts of 1895, as amended by chapter 80 of the Acts of 1897.

The plans submitted by you show extensions from the Neponset valley sewer at three places: 1. Adams Street, Milton Lower Mills; 2. Central Avenue; 3. Near Blue Hill Avenue, Mattapan.

The first plan shows a sewer about 220 feet in length, extending from the Neponset valley intercepting sewer in Baker's Court, Dorchester, through Adams Street, to and across the Neponset River to a point in Milton about 13 feet south of the face of the southerly abutment of the Neponset River bridge, and just beyond a man-hole to be located close to the southerly end of the bridge. This sewer is designed to intercept sewage from an existing sewer in Milton Lower Mills, which now discharges into the Neponset River below the last dam. By the plan submitted, the proposed extension in crossing the Neponset River will be attached to or suspended from the existing bridge.

The plan also shows the method suggested for the connection of the Milton sewer with the metropolitan sewer, involving an inverted siphon, consisting of two 6-inch iron pipes, to convey the sewage beneath the New York, New Haven & Hartford Railroad. In order to secure a greater certainty of the successful operation of the siphon, it is desirable that the pipes be larger, or that ordinary sewer pipes be used instead of iron.

The second plan shows a sewer about 250 feet in length, extending from the Neponset valley intercepting sewer in Central Avenue, Dorchester, to and across the Neponset River to a proposed man-hole on the Milton side of the river, about 10 feet from the southerly end of the Central Avenue bridge. It is proposed to support the sewer upon a portion of the bridge structure where it crosses the river.

The third plan shows a sewer about 195 feet in length, extending from the Neponset valley intercepting sewer at Mattapan Square to and beneath the Neponset River to a point in Milton about 30 feet south of the southerly bank of the river. The place of crossing the river, as indicated by the plan, is about 18 feet east of the present Blue Hill Avenue bridge.

The proposed extensions of the Neponset valley sewer in Central Avenue and Blue Hill Avenue are designed to receive sewage from districts in Milton indicated upon a plan submitted to this Board in 1894 by a sewerage committee of the town of Milton, and approved by the Board Sept. 25, 1894. The proposed extension in Adams Street is designed to receive the dry-weather flow from an existing sewer in the village of Milton Lower Mills. This sewer, it is understood, receives at present both sewage and storm water, but the proposed extension of the Neponset valley sewer is designed to receive only the dry-weather flow from this sewer,

allowing the surplus, at times of storms or melting snows, to be discharged into the Neponset River below the last dam, as at present.

The Board has caused an examination of the location, sizes and grades of the proposed extensions to be made by its engineer, and concludes that they are adapted for the removal of the sewage which it is designed to convey to them; and that, if constructed with care, and if the sewers crossing the river at Adams Street and Central Avenue are attached to and supported by the bridges in such a manner that they may not receive injury from freshets or otherwise, they can be made to operate satisfactorily.

The Board hereby approves the proposed extensions of the Neponset valley sewer in Adams Street, Central Avenue and near Blue Hill Avenue, as described herein.

By order of the Board,

(Signed) SAML. W. ABBOTT,
Secretary.

At the meeting on Dec. 5, 1896, the Tileston & Hollingsworth Company, owners of the Mattapan Mills, Hyde Park, were given a hearing regarding damage to the chimney of said mills, which they claimed had been caused by blasting while constructing the sewer in that neighborhood. After hearing witnesses on both sides, the Board visited the locality early the following week, and later, at the suggestion of said company, agreed to leave the matter to three disinterested parties, one to be selected by the said company, one by this Board, and they jointly to select the third. Charles T. Main, of the firm of Dean & Main, 53 State Street, Boston, was selected by this Board as its representative; Charles H. Manning of Manchester, N. H., was selected by the Tileston & Hollingsworth Company, and Geo. E. Evans, of the firm of Geo. S. Rice & Geo. E. Evans of Boston, was selected as the third referee. After viewing the situation they submitted, on February 6, the following report:—

BOSTON, MASS., Feb. 4, 1897.

Metropolitan Sewerage Commission, Boston, Mass.

GENTLEMEN:—Our opinion of the cause of trouble with Tileston & Hollingsworth Company's chimney at Mattapan is, that primarily it was very faulty workmanship, the development of which may or may not have been accelerated by the blasting in

line of metropolitan sewer. Whether or no these shocks were sufficient to have wrecked the chimney if of good workmanship, there is no way of telling. We consider that the chimney should be repaired at the expense of its contractor.

Respectfully submitted, (Signed) CHAS. H. MANNING.

(Signed) CHAS. T. MAIN.

(Signed) GEO. E. EVANS.

A copy of this opinion was submitted to the Tileston & Hollingsworth Company by said referees, and ended the matter so far as this Board was concerned.

CONNECTIONS WITH THE METROPOLITAN SEWER ON THIS SYSTEM.

The following connections have been authorized with the metropolitan sewer on this system at this date (Oct. 1, 1897) : —

DATE AUTHORIZED.	City or Town.	Location of Connection.	Size.	Date of Completion.
July 10, 1897,	Boston,*	River Street, near Fremont Street,†	15 inch,	July 13, 1897.
July 3, 1897,	Hyde Park,	Fairmount Avenue, between New England Railroad and Neponset River,	12 inch,	Aug. 6, 1897.
July 3, 1897,	Hyde Park,	Opposite extension of Milton Avenue, foot of Walter Street,	18 inch,	To be made.
July 3, 1897,	Hyde Park,	Arlington Street, corner Metro- politan Avenue,	15 inch,	Aug. 6, 1897.
July 3, 1897,	Hyde Park,	Hyde Park Avenue, near Factory Street,	12 inch,	July 14, 1897.
July 10, 1897,	Hyde Park,	Hyde Park Avenue, near Factory Street,	20 inch,	To be made.
Aug. 11, 1897,	Hyde Park,	Corner Business Street and Barry Place,	15 inch,	Sept. 7, 1897.
Sept. 4, 1897,	Milton,	Blue Hills Parkway,	12 inch,	To be made.

* Dorchester. † Connected, but not in operation.

The expenditures upon this system for the year have been \$405,486.31. This, with the amount previously reported, \$203,254.30, makes \$608,740.61 expended to date. Table F of the Appendix shows the amount expended for maintenance to Oct. 1, 1897.

On Monday, Oct. 12, 1896, Albert F. Noyes, a member of this Board, while hastening to take a train for Dedham in the Park Square Station of the New York, New Haven & Hartford Railroad, died suddenly of heart disease. Out of respect to his memory, the office of the Board was closed on the day of the funeral, and the services, which occurred at the Episcopal Church, Auburndale, were attended by the other members of the Board, the clerk, chief engineer and numerous other employees, floral tributes being sent in behalf of the Board and the employees thereof. At the meeting of Saturday, Oct. 17, 1896, the Board unanimously adopted the following resolutions, presented by the chairman : —

Resolved, That, by the death of Albert F. Noyes, this department of the Commonwealth has lost a conscientious, zealous and efficient public servant, and we a genial companion, faithful friend and most agreeable associate.

Resolved, That the foregoing be spread upon the records of the Board, and a copy thereof transmitted to his family.

In accordance with the last resolution, the following communication, with a copy of the resolutions, was sent and duly acknowledged : —

COMMONWEALTH OF MASSACHUSETTS,
BOSTON, Oct. 23, 1896.

At the meeting of this Board, held Oct. 17, 1896, the accompanying resolutions, which are self-explanatory, were unanimously passed, and in accordance therewith I transmit the enclosed copy.

For the Board,

Very sincerely and respectfully yours,

(Signed) EDWARD P. FISK,

Clerk.

To the family of the late ALBERT F. NOYES.

At the meeting on Saturday, Nov. 7, 1896, George A. Kimball of Somerville, who had been appointed by the acting governor and confirmed by the council as Mr. Noyes's successor, appeared, showing his commission as a member of

this Board, and assumed the duties of the office, making the sixth commissioner who has qualified upon this Board since its organization. Tilly Haynes of Boston was appointed and commissioned as his own successor on this Board in January last. This is his third appointment, and upon the completion of this term he will have served eleven years thereon.

At the annual meeting of the Board, held, as provided in the act (chapter 439, Acts of 1889), on the first Monday of February (February 1), 1897, Hosea Kingman of Bridgewater was again chosen chairman and Edward P. Fisk clerk for the year.

At its meeting on Aug. 25, 1897, the Board unanimously passed the following vote, which is self-explanatory :—

Voted, That, because of the sickness and temporary absence of our clerk, Edward P. Fisk, Herbert E. Brayton is hereby selected and appointed as acting clerk during such absence.

The recommendations made in this report, summarized briefly, are : that the State acquire or take the trunk line of the Boston main drainage system from the outlet to the corner of Huntington Avenue and Gainsborough Street, Boston, and that provision be made to defray the expense thereof. This matter was referred to the incoming Legislature by its predecessor ; the appropriation of a sufficient sum to enable the preliminary studies, borings, plans, etc., to be made regarding the high-level sewer, reported by the engineer as necessary for the relief of the Charles and Neponset districts ; the appropriation of \$142,500 to provide additional pumping plant at each of the pumping stations on the north metropolitan system, and also \$75,000 to settle land damages on said system.

These acts can be prepared and submitted to the committee of your honorable body authorized to report thereon.

The Appendix contains tables showing in detail the receipts and expenditures for the year, also the assets and liabilities to date.

HOSEA KINGMAN,
TILLY HAYNES,
GEORGE A. KIMBALL,

Metropolitan Sewerage Commissioners.

REPORT OF CHIEF ENGINEER

AND

SUPERINTENDENT.

REPORT OF CHIEF ENGINEER

AND

SUPERINTENDENT.

Boston, Sept. 30, 1897.

HOSEA KINGMAN, TILLY HAYNES, GEORGE A. KIMBALL,
Metropolitan Sewerage Commissioners.

GENTLEMEN:— Within the North Metropolitan area are now approximately 45.6 miles of completed Metropolitan Sewers. The location of these sewers and other data in relation to them are outlined in the following table:—

*Table showing Locations, Lengths and Sizes of Metropolitan Sewers within the North Metropolitan Area and the Number of Public and Special Connections made with the System in Each City and Town.**

CITY OR TOWN.	Size of Sewers.	Length in Miles.	Public Connections, Sept. 30, 1897.	SPECIAL CONNECTIONS.	
				Character or Location of Connection.	Number in Operation.
Boston:—					
Deer Island,	6' 3" to 9',	1.367	1	- -	-
East Boston,	6' to 1',	5.467	3	- -	-
Charlestown,	6' 7"×7' 5" to 1' 3", . . .	3.292	3	Navy Yard, . .	1
Winthrop, . .	9',	2.864	4	- -	-
Chelsea, . . .	8' 4"×9' 2" to 2' 1"×2' 10",	2.212	2	Rendering works, .	1
Everett, . . .	8' 2"×8' 10" to 4' 8"×5' 1",	2.925	2	Metropolitan Water Board, blow-off.	1
Malden, . . .	3' 9"×4' 1" to 2', . . .	1.857	4	Metropolitan Water Board, blow-off.	1
Melrose, . . .	1' 10"×2' 9" to 10", . . .	3.493†	3	Private houses on sewer purchased from town of Melrose.	6
Cambridge, . .	5' 2"×5' 9" to 1' 3", . . .	5.963	17	Slaughter-house, .	1
Somerville, . .	6' 5"×7' 2" to 1' 10"×2' 3",	3.471	4	Slaughter-houses (3),	1
Medford, . . .	4' 8"×5' 1" to 10", . . .	5.359	14	Private houses, . .	2
Winchester, . .	2' 11"×3' 3" to 1' 3", . . .	6.403	8	Tannery,	1
Stoneham, . . .	1' 3" to 10",	0.010	2	- -	-
Woburn, . . .	1' 10"×2' 4" to 1' 3", . . .	0.933	3	Glue factory, . . .	1
Arlington, . .	1' 6" to 10",	0.036	3	- -	-
Belmont, . . .	- - - -	-	1	- -	-
Wakefield, . .	- - - -	-	-	- -	-
		45.652‡	74		15

* The Metropolitan Sewer extends but a few feet into the towns of Belmont and Wakefield.

† This includes .736 of a mile of sewer purchased from the town of Melrose and the completed portions of Sections 50 and 51 (Wakefield and Stoneham branches), .35 of a mile of sewer remaining to be completed on these sections Sept. 30, 1897.

‡ This includes 2.7 miles of Mystic Valley Sewer in Medford, Winchester and Woburn running parallel with the Metropolitan Sewer.

At the end of the year a length of about 44.3 miles is receiving sewage from a population of 193,000 people, or about 50 per cent. of the total resident population on the area.

During the year extensions of the system have been made within the area to Wakefield and Stoneham, as authorized by chapter 414 of the Acts of 1896 and chapters 88 and 436 of the Acts of 1897. These acts provide a total appropriation of \$45,000, and involve the purchase of a portion of the main sewer of the town of Melrose, consisting of small pipe and brick sewers, and extending from the corner of Pleasant Street and Wyoming Avenue to the corner of Lake Avenue and Tremont street, a distance of about .74 of a mile.

Table showing Locations, Lengths and Sizes of Sewer purchased from the Town of Melrose, authorized by Chapter 414 of the Acts of 1896, and now known as Section 49 of the Metropolitan Sewerage System.

LOCATION.	SIZE.		Brick or Pipe.
	Diameter (Inches).	Length (Feet).	
Wyoming Avenue,	20	29.24	Brick.
Wyoming Avenue,	24	16.58	Brick.
Private land of Boston & Maine Railroad, Berwick and Grove streets,	24	794.81	Pipe.
Myrtle, Essex and Tremont streets,	18	2,704.25	Pipe.
Tremont Street to Lake Avenue,	15	343.16	Pipe.
Total length,		3,888.04	
Regulator and overflow at Wyoming Avenue, and 21 man-holes.			

Fifteen thousand dollars have already been paid to the town of Melrose for this length of sewer, which, since Nov. 25, 1896, has been operated as a part of the Metropolitan System.

Contracts for the remainder of the extensions to Wakefield and Stoneham have been made as follows :—

On Sept. 30, 1897, there remained to be completed of the above contracts about .35 of a mile of pipe sewers. It is anticipated that Sections 50 and 51 will be complete and open for service about Dec. 1, 1897. The expenditures to date on the extensions have been as follows :—

Purchase of a portion of the town sewers, . . .	\$15,000 00
Cost of construction to date,	19,320 48
Total expenditures to date,	\$34,320 48

Within the Charles River Valley area are now approximately 8.1 miles of Metropolitan Sewers, which have been in operation since May 1, 1892, located as follows :—

Table showing Locations, Lengths and Sizes of Metropolitan Sewers within the Charles River Valley Area and the Number of Public and Special Connections made with the System in Each City and Town.

CITY OR TOWN.	Size of Sewers.	Length in Miles.	Public Connections, Sept. 30, 1897.	SPECIAL CONNECTIONS.	
				Character or Location of Connection.	Number in Operation.
Part of Boston proper.	6' 6" to 5' 6", . . .	1.500	8	Administration building, Boston Park Department.	1
Boston (Brighton).	5' 6" to 4' 2"×4' 9", . . .	3.688	10	Abattoirs, . . .	3
Brookline, .	5' 6",	0.127	1	- -	-
Newton, .	4' 2"×4' 9" to 3' 6"×4', . .	2.057	6	Private houses, . .	2
Watertown, .	4' 2"×4' 9" to 3' 11"×4' 5", .	0.725	5	Factory, . . .	1
Waltham, .	3' 6"×4',	0.001	1	- -	-
		8.098	31		7

At the end of the year these sewers were receiving sewage from a population of 67,500, or about 62.9 per cent. of the total resident population on the area.

No extensions of the Metropolitan Sewer in this valley have been made during the year.

For the town of Watertown a siphon has been built under the Charles River from the abattoir grounds in Brighton to the arsenal grounds in East Watertown. The cost of this construction has been paid by the town of Watertown.

In the Neponset River Valley, at the beginning of the year, sewers were constructed and in process of construction from Central Avenue in Dorchester to a point in Dedham near the West

Roxbury line, a distance of about 6.75 miles. During the year this construction has been completed and the sewer opened for service through Dorchester and Hyde Park for a distance of 6.25 miles.

Chapter 83 of the Acts of 1897 provides an appropriation for the extension of the Neponset Valley Interceptor through West Roxbury to a point near the Brookline town line, the construction having been authorized by chapter 406 of the Acts of 1895. Contracts for this work were arranged early in the year for a distance of about 3.18 miles, of which 2.3 miles are now completed. It is anticipated that the whole construction will be finished on or about Jan. 1, 1898.

The sewer, as designed to be built through West Roxbury, follows in marsh lands along the northerly and easterly shore of the Charles River to Gardner Street; thence easterly along the Brookline water works' taking, in private and marsh lands, to Baker Street; thence through St. Joseph's Cemetery, La Grange, Weld and Newfield streets, and in private land on easterly side of brook; thence crossing Worley Street to a point in Weld Street about 300 feet east of Gould Avenue.

Chapter 80 of the Acts of 1897 directs that branch sewers from the Neponset Valley Interceptor be extended across the Neponset River to and into the town of Milton to provide connections from her local sewers with the Metropolitan System. Three such river crossings have been built by “day work” during the year, viz., at Mattapan Square, Central Avenue and Milton Lower Mills, at a total cost of \$5,736.86.

The total expenditure to date on account of the Neponset Valley Intercepting Sewer from Central Avenue, Dorchester, to Weld Street, West Roxbury, near the Brookline town line, has been \$608,740.61.

Table showing Locations, Lengths and Sizes of Metropolitan Sewers within the Neponset River Valley Area and the Number of Public Connections made with the System in Each City and Town.

CITY OR TOWN.	Size of Sewer.	Length in Miles.	Number of Public Connections.
Milton,	1' 8" to 8",	0.05	-
Boston (Dorchester),	3'×3' 1" to 2' 6"×2' 7",	1.63	-
Hyde Park,	4' 6"×4' 7" to 4'×4' 1",	3.09	4
Dedham,	4'×4' 1" to 3' 9"×3' 10",	2.35	-
Boston (West Roxbury),	3' 9"×3' 10" to 1',	2.94	-
		10.06	4

A detailed statement relating to construction and maintenance during the year follows :—

SECTION 50 (WAKEFIELD BRANCH), MELROSE AND WAKEFIELD.

Location.—From a point at the junction of Lake Avenue and Tremont Street extending to the junction of Tremont and Melrose streets; thence to the junction of Melrose and Belmont streets (passing under the stone arch bridge of the Boston & Maine Railroad); thence to the junction of Belmont and Franklin streets; thence to a point on Greenwood Street at the Melrose and Wakefield town line.

Diameters of pipe sewers and length of each size :—

1 foot 6 inches, 250 feet.
 1 foot 3 inches, 2,005 “
 1 foot, 1,078 “

Diameters and length of brick sewers :—

1 foot 6 inches by 1 foot 8 inches, 1,330 feet.

Contractors.— John Booth Company of Winchester, Mass.

Contractors' Superintendent.— John Bozzo.

*State Assistants.**

Assistant Engineer: Frank I. Capen.
 Inspectors: Michael F. Garra, Charles G. Waitt.
 Transitmen: Principal— William M. Stodder.
 Assistant— William J. Fielding, John L. Hodgson.

* The above-named State assistants have been employed for a part of the time only on Section 50.

Trench.

	18-Inch Pipe Sewer.	18-Inch by 20-Inch Brick Sewer.	15-Inch Pipe Sewer.	12-Inch Pipe Sewer.
Length of trench excavated to bottom of under- drain (feet),	250.00	-	1,800.00	400.00
Length of trench excavated to bottom of pile cap (feet),	-	1,330.00	-	-
Average depth of trench excavation to bottom of underdrain (feet),	11.00	-	12.00	18.00
Average depth of trench excavation to bottom of pile cap (feet),	-	9.00	-	-
Greatest depth of trench excavation to bottom of underdrain (feet),	16.00	-	16.00	19.00
Greatest depth of trench excavation to bottom of pile cap (feet),	-	11.00	-	-
Average width, top of trench (feet),	2.65	3.15	4.00	3.15
Average width, bottom of trench (feet),	2.65	3.15	3.00	3.00
Volume of trench excavation per linear foot (cubic yards),	1.10	1.30	1.55	2.00
Approximate cost of trench per linear foot, in- cluding sheeting left in, excavation and refilling below masonry, back-filling, etc., to date (Sept. 30, 1897),	\$2 05	\$1 87*	\$1 27	\$1 20

* Does not include piles.

Character of Excavation. — From the junction of Lake Avenue and Tremont Street to a point 185 feet beyond, 6 inches road surfacing and sand to grade; for the next 650 feet, 6 inches road surfacing followed by filling and peat to grade; for the next 350 feet, 6 inches surfacing followed by fine sand to grade; for the following 300 feet, 6 inches road surfacing, then filling and peat to grade; then to a point 30 feet southerly from the southerly end of Union Street, road surfacing, sand and gravel, then peat and sand to grade; then to a point about 180 feet westerly from the junction of Melrose and Tremont streets, sand and gravel to grade; from this point to about 30 feet southerly from the southerly line of Belmont Court, gravel with rock below; then to a point at about the junction of Belmont and Franklin streets, coarse gravel and sand; from the junction of Franklin and Greenwood streets for about 450 feet northerly, loam, sand, gravel and about 8 feet of rock to grade.

Masonry.

Contract prices : —

Brickwork, American cement mortar, per cubic yard,	\$10 50
Brickwork, Portland cement mortar, per cubic yard,	12 00
Concrete, American cement mortar, per cubic yard,	5 50
Concrete, Portland cement mortar, per cubic yard,	7 00

Diameters of underdrain laid and length of each size : —

3-inch,	390 feet.
4-inch,	653 “
6-inch,	2,315 “

Approximate cost of masonry per linear foot of trench, including under-
drain, tarred paper, etc., to date (Sept. 30, 1897), \$2.29.

Length of masonry completed, 1,330 feet.

Masonry begun in trench June 4, 1897; finished Sept. 10, 1897.

Approximate cost per linear foot of excavation and masonry, including
labor, material, inspection and miscellaneous items, to date (Sept.
30, 1897), \$4.31.

Excavation.

	Opening No. 1.	Opening No. 2.	Opening No. 3.	Opening No. 4.	Opening No. 5.
Character of opening,	Open cut,	Open cut,	Open cut,	Open cut,	Open cut.
Date of starting, . . .	May 10, 1897, . . .	July 19, 1897, . . .	Sept. 10, 1897, . . .	May 11, 1897, . . .	May 11, 1897.
Point of beginning, . .	Junction of Lake Avenue and Tremont Street.	450 feet southerly from Union Street.	Junction of Tremont and Melrose streets.	Junction of Melrose and Belmont streets.	Junction of Franklin and Greenwood streets.
Point of ending, or where work was in progress Sept. 30, 1897.	450 feet southerly from centre line of Union Street.	Junction of Melrose and Tremont streets.	Junction of Melrose and Belmont streets.	80 feet southerly from the junction of Belmont and Franklin streets.	400 feet northerly from the junction of Franklin and Greenwood streets.
Date of finishing, . . .	Sept. 10, 1897, . . .	Aug. 27, 1897, . . .	Sept. 30, 1897, . . .	In progress Sept. 30, 1897,	In progress Sept. 30, 1897.
Length,	1,580 feet,	773 feet,	297 feet,	650 feet,	400 feet.
Ordinary progress per week,	80 feet,	120 feet,	99 feet,	30 feet,	20 feet.
Appliances used, . . .	Hand labor,	Hand labor,	Hand labor,	Hand labor,	Hand labor.
Size of gang ordinarily employed.	20 men,	23 men,	13 men,	10 men,	12 men.

The ground-water was raised by a 4-inch centrifugal pump first located at a point 250 feet northerly from the junction of Lake Avenue and Tremont Street, and afterwards at the angle in Tremont Street about 1,000 feet from the above-named junction. The estimated maximum rate of pumping in 24 hours was 300,000 gallons.

Foundation. — On Tremont Street for 100 feet, beginning at a point about 600 feet south of the southerly line of Union Street, it was found necessary to excavate to a depth of about 1 foot 3 inches below grade and refill with gravel, the material removed consisting mainly of peat.

A pile foundation was introduced for about 600 feet on Tremont Street. The bottom excavation has been either of sand, gravel or ledge for the remainder of the section.

Precautions. — On Tremont Street, where the sewer was built in shallow cut, the sheeting was left in and $\frac{5}{8}$ -inch tie-rods were placed across the sewer every 8 feet to guard against spreading of the completed structure.

SECTION 51 (STONEHAM BRANCH), MELROSE AND STONEHAM.

Location. — From a point in Tremont Street, Melrose, about 1,500 feet north of Lake Avenue, extending through private lands, Brunswick Way, Brunswick Park, Vinton and Melrose streets and Franklin Terrace to a point in Franklin Street, Stoneham, about 1.33 feet beyond the Melrose and Stoneham town line.

Diameters and lengths of pipe sewer: —

1-foot,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3,148.00 feet.
10-inch,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	975.37 "

Contractors. — The A. W. Bryne Construction Company of Boston, Mass.

Contractors' Superintendent. — James L. Byrne.

Contractors' Principal Foreman. — J. Andrew Hunter.

*State Assistants.**

Assistant Engineer: Frank I. Capen.

Inspectors: Michael F. Garra, Charles G. Waitt.

Transitmen: Principal — William M. Stodder.

Assistant — William J. Fielding, John L. Hodgson.

Trench and Tunnel.

	10-Inch and 12-Inch Pipe Sewer.
Length of trench excavated to bottom of gravel refilling (feet), . . .	3,117.80
Length of tunnel excavated to bottom of concrete (feet), . . .	110.00
Average depth of trench excavation to bottom of gravel refilling (feet),	9.50
Greatest depth of trench excavation to bottom of gravel refilling (feet),	14.50
Average width, top of trench (feet),	3.00
Average width, bottom of trench (feet),	2.00

* The above-named State assistants have been employed for part of the time only on Section 51.

10-Inch and 12-Inch
Pipe Sewer.

Average depth from surface of ground to bottom of tunnel excavation (feet),	23.00
Greatest depth from surface of ground to bottom of tunnel excavation (feet),	23.00
Average width of tunnel excavation (feet),	4.00
Volume of trench excavation per linear foot (cubic yards), . . . .	.79
Volume of tunnel excavation per linear foot (cubic yards), . . . .	.66
Approximate cost of trench per linear foot, including pipe, sheeting left in, excavation and refilling below masonry, back-filling, etc., to Sept. 30, 1897, \$1.24.	
Approximate cost of rock excavation per linear foot, \$0.44.	
Approximate cost of tunnel excavation per linear foot, including pipe excavation and refilling below masonry, back-filling, etc., to Sept. 30, 1897, \$1.41.	

Character of Excavation. — From a point at the beginning of the section on Tremont Street, about 450 feet south of Union Street, the excavation was open cut for 227 feet through 1 foot loam, 7 feet sand and gravel; then tunnel for 110 feet through sand and boulders; then open cut for 190 feet through 1 foot loam, 5 feet sand and fine gravel; then open cut for 150 feet through 1 foot loam, 10 feet soft brown peat; then open cut for 200 feet through 1 foot loam, 1 foot brown peat and 3 feet sand; then open cut for 548 feet through 1 foot loam, 6 feet sand and gravel; then open cut for 260 feet with 2 feet of street surfacing, 8 feet sand and coarse gravel; then open cut for 865 feet through 1 foot loamy sand, 5 feet sand and gravel; then open cut for 200 feet through 2 feet street surfacing, 6 feet sand and coarse gravel; then open cut for 398 feet through 2 feet street surfacing and 4 feet ledge to a point corner of Franklin Street and Franklin Terrace.

Masonry.

Contract prices : —

Brickwork, American cement mortar, per cubic yard,	\$13 00
Brickwork, Portland cement mortar, per cubic yard,	15 00
Concrete, American cement mortar, per cubic yard,	6 00
Concrete, Portland cement mortar, per cubic yard,	7 00

Diameter and length of underdrain :—

6-inch,	1,079 feet.
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Approximate cost of masonry per linear foot of trench, including underdrain, tarred paper, etc., to Sept. 30, 1897, \$0.36.*

Approximate cost of masonry per linear foot of tunnel, including underdrain, tarred paper, etc., to Sept. 30, 1897, \$3.69.†

Approximate cost of section per linear foot of excavation, pipe and masonry, including labor, material, inspection and miscellaneous items, to Sept. 30, 1897, \$2.27.

* This includes brick masonry at man-holes, concrete used in reinforcing pipe, etc.

† Concrete used for back-filling.

Excavation.

	Opening No. 1.	Opening No. 2.	Opening No. 3.	Opening No. 4.
Character of opening,	Open cut,	Tunnel,	Open cut,	Open cut.
Number of tunnel headings, . .	-	One,	-	-
Date of starting,	July 15, 1897,	Aug. 5, 1897,	Aug. 20, 1897,	Aug. 30, 1897.
Point of beginning,	1,570 feet north of Lake Avenue,	Easterly from boundary of Bos-	Westerly side, Boston & Maine	Junction Vinton and Melrose
Point of ending, or where work	Easterly boundary, Boston &	ton & Maine Railroad location.	Railroad location.	streets.
was in progress Sept. 30, 1897.	Maine Railroad location.	Westerly side, Boston & Maine	Junction Vinton and Melrose	Franklin Street, near Franklin
Date of finishing,	Aug. 1, 1897,	Aug. 29, 1897,	Sept. 13, 1897,	In progress Sept. 30, 1897.
Length,	228 feet,	110 feet,	1,347 feet,	2,438.37 feet.
Ordinary progress per week, . .	113.6 feet,	32 feet,	240 feet,	300 feet.
Appliances used,	Hand labor,	Hand labor and wheelbarrows, .	Hand labor,	Hand labor.
Size of gang ordinarily employed,	10 men,	4 men,	15 men,	20 men.

A 6-inch piston pump, located at a point near Tremont Street, disposed of the ground-water for 1,000 feet. The estimated maximum rate of pumping in 24 hours was 500,000 gallons.

Foundation. — In Brunswick Park, for a distance of about 158 feet, it was necessary to excavate in peat below the bottom of the masonry to a depth varying from 1 to 12 feet, and refill with cheap concrete.

The bottom excavation has been generally of coarse gravel and sand. Where boulders and ledge have been encountered, the trench was excavated to a depth of 6 inches below grade and refilled with fine sand, on which the sewer pipe was laid. In coarse sand the trench was excavated to grade and the pipe laid on the firm, undisturbed bottom, where underdrain was omitted.

Precautions. — Under the Boston & Maine Railroad, heavy stringers, 40 feet in length, were placed under each rail while the operations under the railroad were in progress.

Occasionally the pipe was surrounded with concrete to increase its strength and prevent leakage.

Miscellaneous. — Some interference with the street-railroad traffic occurred on Franklin Street, where the sewer line was located in the centre of the track.

A slight change in the sewer line was made to avoid a well in the property of Mr. F. A. Messenger.

EAST WATERTOWN SIPHON, WATERTOWN AND BRIGHTON.

Location. — From the arsenal grounds of the United States government in Watertown, across and under the Charles River to a point in land owned by the Butchers' Slaughtering and Melting Association in Brighton.

Contractors. — Perkins & White of Boston, Mass.

State Assistants.

Assistant Engineer : Frank I. Capen.*

Inspector and Transitman : William M. Stodder.

At the request of the sewerage commissioners of the town of Watertown a siphon was constructed under the Charles River for delivering sewage to the intercepting sewer in Brighton from an area of about 700 acres in the eastern portion of the town of Watertown. The work was designed and built by contract, under the direction of the office of the Metropolitan Sewerage Commission. The cost of the construction of the siphon and connected structures was paid by the town of Watertown.

* Employed for a portion of the time only on this work.

Character of Structure and Method of Construction. — The siphon consists of about 250 linear feet of 12-inch, extra-heavy, cast-iron water pipe, laid about 3 feet below the proposed improved channel of Charles River, at a depth of about 10 feet below low water of the stream. It is a level pipe, with masonry shafts and stop-plank chamber on both shores. On the Brighton side the shaft is connected with the Metropolitan Sewer by a 7-foot length of 24-inch brick sewer.

The masonry shafts were constructed by first driving coffer-dams of 4-inch tongued and grooved hard pine timber in 32-foot lengths. These coffer-dams were lined with concrete and brick masonry, the finished inside dimensions being about 4 by 5 feet by 30 feet in depth. For laying the pipe a trench about 10 feet wide was dredged across the river. For securing the pipe at grade, piles were driven in bents of 2 every 6 feet. Divers attached cross-ties to these piles above and below the pipe. The pipe with leaded joints was lowered into place in two lengths, and the connecting joint at the middle of the river made with cold lead by divers. This joint was further reinforced by iron straps and surrounded by concrete.

Only one-half of the clear water-way of the river was obstructed at any one time. The work of construction was begun in October, 1896, and completed in May, 1897.

Cost. — The total cost, including engineering, inspection and miscellaneous items, was \$9,591.67.

SECTION 12, NEPONSET VALLEY SYSTEM (DAY WORK), DORCHESTER.

Location. — From the end of the Dorchester Intercepting Sewer, built by the city of Boston, to Central Avenue, through Central Avenue and westerly through the property of the Tileston & Hollingsworth Company (Eagle Mills), across an arm of the mill-pond and private land to a point in the property of Abba M. Martine.

Diameter and length of sewer : —

3 feet by 3 feet 1 inch, 985 feet.

Assistants.

Assistant Engineer : Frank I. Capen.

Foreman : Patrick McCarthy.

Transitman : William M. Stodder.

Trench and Tunnel.

	3 Feet by 3 Feet 1 Inch Sewer.
Length of trench excavated to bottom of underdrain (feet), . .	602 00
Length of tunnel excavated to bottom of underdrain (feet), . .	383.00
Average depth of trench excavation to bottom of underdrain (feet), .	16.00
Greatest depth of trench excavation to bottom of underdrain (feet), .	18.00
Average width, top of trench (feet),	6.30

	3 Feet by 3 Feet 1 Inch Sewer.
Average width, bottom of trench (feet),	6.10
Average depth from surface of ground to bottom of tunnel excavation (feet),	26.00
Greatest depth from surface of ground to bottom of tunnel excavation (feet).	30.00
Average width of tunnel excavation (feet),	5.00
Volume of trench excavation per linear foot (cubic yards), . . .	4.00
Volume of tunnel excavation per linear foot (cubic yards), . . .	1.00
Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below masonry, back-filling, etc., to com- pletion of work, \$10.36.*	
Approximate cost of tunnel excavation per linear foot, including exca- vation and refilling below masonry, back-filling, etc., to completion of work, \$17.62.	

Character of Excavation.—For the first 212 feet the excavation was in gravel and sand, with rock in the bottom of the trench, followed by about 383 feet of rock tunnel; then for 230 feet across the mill-pond there were 7 feet of filling, 2 feet of mud and gravel to grade. For the remainder of the distance the excavation was in loam, filling and gravel.

Diameters of underdrain laid and length of each size :—	
4-inch,	485 feet.
8-inch,	390 "

Approximate cost of masonry per linear foot of trench, including under- drain, tarred paper, etc , to completion of work, \$6.64.	
Approximate cost of masonry per linear foot of tunnel, including under- drain, tarred paper, etc., to completion of work, \$7.26.	
Length of masonry completed (trench),	602 feet.
Length of masonry completed (tunnel),	383 "
Masonry was begun in trench May 2, 1896; finished Dec. 5, 1896.	
Masonry begun in tunnel Sept. 23, 1896; finished Nov. 24, 1896.	
Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, to com- pletion of work, \$21.51.	

NOTE.—The information regarding Section 12 following this note relates solely to the year ending Sept. 30, 1897. For a description of the work performed prior to this year, see the eighth annual report.

Excavation.—The ground-water in the tunnel was raised by ejectors; in the open-cut work crossing the mill-pond an 8-inch centrifugal pump was used. The tunnel heading referred to in last year's report as having been commenced on Aug. 25, 1896, was continued to meet the heading from the opposite direction. The excavation was wholly in very hard rock, and was worked with steam drills.

In driving the tunnel increased care was used because of its location under buildings and alongside water filters and other works of the Tileston & Hollingsworth Company. Its peculiar location

* This does not include the cost of the embankment and riprap across the mill-pond.

and the unusual hardness of the rock through which the tunnel was driven added much to the cost of the work.

Cost.—The cost of this section, exclusive of engineering, was approximately \$21,190.

SECTION 13 (NEPONSET VALLEY SYSTEM), DORCHESTER.

Location.—From a point in private land, on the southerly bank of the Neponset River, about 1,000 feet west of Central Avenue, extending westerly in proposed streets through private land of John Conness and Thomas Liversidge estate to River Street, a distance of about 2,900 feet; thence in River Street to about 120 feet east of the centre line of Fremont Street.

Diameter and length of sewer :—
3 feet by 3 feet 1 inch, 3,800 feet.

Contractor.—Harry P. Nawn of Roxbury, Mass. Mr. Nawn has acted as superintendent.

Contractor's Principal Foreman.—John Ellwood.

State Assistants.*

- Assistant Engineer : C. Barton Pratt.
- Inspectors : S. B. Horton, John D. Collins.
- Transitmen : Principal — Charles Kincaid, G. E. Stratton.
- Assistant — M. F. Sanborn.

Trench and Tunnel.

	3 Feet by 3 Feet 1 Inch Sewer.
Length of trench excavated to bottom of underdrain (feet),	3,408.00
Length of tunnel excavated to bottom of underdrain (feet),	392.00
Average depth of trench excavation to bottom of concrete (feet),	11.80
Greatest depth of trench excavation to bottom of concrete (feet),	20.90
Average width, top of trench (feet),	5.50
Average width, bottom of trench (feet),	5.40
Average depth from surface of ground to bottom of tunnel concrete (feet),	18.60
Greatest depth from surface of ground to bottom of tunnel concrete (feet),	26.80
Average width of tunnel excavation (feet),	5.70
Volume of trench excavation per linear foot (cubic yards),	2.40
Volume of tunnel excavation per linear foot (cubic yards),	1.30
Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below masonry, back-filling, etc., to completion of work, \$3.95.	
Approximate cost of tunnel excavation per linear foot to completion of work, \$7.	

Character of Excavation.—For 180 feet from beginning of section, 1 foot loam, then sand, gravel and boulders to grade; then for 250 feet, 1 foot loam, the formation below this being sand and gravel, followed by ledge averaging about 5 feet in depth to grade; thence for 318 feet, 1 foot loam followed by sand and gravel to grade; thence for 250 feet, a rock tunnel; the rock tunnel then continues for 142 feet through sand, gravel, clay and boulders. The trench begins again with 1 foot loam

* The above-named State assistants have been employed for part of the time only on Section 13.

6 feet sand and gravel, then fine sand to grade, extending for about 500 feet, changing here to loam, sand and gravel for 1,500 feet, at which point the excavation was through 1½ feet road-bed, then sand and gravel with a bottom of ledge for 220 feet, changing again to road-bed, then sand, clay and gravel for 440 feet to the end of the section.

Masonry.

Contract prices : —

Brickwork, American cement mortar, per cubic yard (trench),	. .	\$12 50
Brickwork, American cement mortar, per cubic yard (tunnel),	. .	15 00
Brickwork, Portland cement mortar, per cubic yard (trench),	. .	14 00
Brickwork, Portland cement mortar, per cubic yard (tunnel),	. .	16 00
Concrete, American cement mortar, per cubic yard (trench),	. .	5 00
Concrete, American cement mortar, per cubic yard (tunnel),	. .	7 00

Diameters of underdrain laid and length of each size : —

6-inch,	904 feet.
8-inch,	2,896 “

Approximate cost of masonry per linear foot of trench, including underdrain, tarred paper, etc., to completion of work, \$4.24.

Approximate cost of masonry per linear foot of tunnel, including underdrain, tarred paper, etc., to completion of work, \$5 02.

Length of masonry completed (trench),	3,408 feet.
Length of masonry completed (tunnel),	392 “

Masonry begun in trench April 16, 1896; finished Jan. 18, 1897.

Masonry begun in tunnel Nov. 20, 1896; finished Jan. 15, 1897.

Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, to completion, \$8.94.

NOTE. — The information regarding Section 13 following this note relates solely to the year ending Sept. 30, 1897. For a description of the work performed prior to this year, see the eighth annual report.

Excavation.

	Opening No. 2.	Opening No. 4.
Character of opening, . . .	Tunnel,	Tunnel.
Number of tunnel headings, .	One,	One.
Date of starting,	July 8, 1896,	July 8, 1896.
Point of continuing from last year's work,	836 feet from beginning of section.	986 feet from beginning of section.
Point of ending,	906 feet from beginning of section.	906 feet from beginning of section.
Date of completion, . . .	Nov. 10, 1896,	Nov. 10, 1896.
Length,	70 feet,	80 feet.
Ordinary progress per week, .	9 feet,	16 feet.
Appliances used,	Wheelbarrows,	Wheelbarrows.
Size of gang ordinarily employed,	8 men,	8 men.

A 6-inch centrifugal pump, located at the lower end of the section, handled the ground-water.

Foundation. — The formation throughout this section has been of ledge, sand, gravel and clay. An American concrete invert, 6 inches in depth on the bottom and 8 inches in thickness on the sides at the springing line, has been laid, on which was built a 4-inch invert of brick masonry. The arch of the sewer throughout the section is 8 inches in thickness.

Surplus Material. — The surplus rock has been used in the construction of roads in the vicinity of the sewer, the surplus earth for filling near-by low lands.

SECTION 14 (NEPONSET VALLEY SYSTEM), DORCHESTER.

This section was completed prior to Sept. 30, 1896.

SECTION 15 (NEPONSET VALLEY SYSTEM), DORCHESTER AND HYDE PARK.

Location. — From a point in River Street, Dorchester, about 270 feet west of Oakland Street, extending westerly through River Street to a point in Hyde Park about 20 feet east of Wachusett Street.

Diameters of sewers and length of each size:—

2 feet 6 inches by 2 feet 7 inches,	. . . . .	1,464.00 feet.
4 feet 6 inches by 4 feet 7 inches,	. . . . .	1,006.30 “

Contractor. — Harry P. Nawn of Roxbury, Mass. Mr. Nawn has acted as superintendent.

Contractor's Principal Foreman. — William Hall.

*State Assistants.**

- Assistant Engineer: C. Barton Pratt.
- Inspectors: Michael F. Garra, Charles G. Waitt.
- Transitmen: Principal — Henry Cleary, G. E. Stratton, Charles Kincaid.
Assistant — M. F. Sanborn, Walter Cleary.

Trench and Tunnel.

	2 Feet 6 Inches by 2 Feet 7 Inches Sewer.	4 Feet 6 Inches by 4 Feet 7 Inches Sewer.
Length of trench excavated to bottom of underdrain (feet), . . .	1,464.00	507.00
Length of tunnel excavated to bottom of underdrain (feet), . . .	—	499.30
Average depth of trench excavation to bottom of concrete (feet), .	15.60	18.90
Greatest depth of trench excavation to bottom of concrete (feet),	17.40	19.20
Average width, top of trench (feet),	5.50	8.60
Average width, bottom of trench (feet),	5.00	6.70
Average depth from surface of ground to bottom of tunnel con- crete (feet),	—	24.90
Greatest depth from surface of ground to bottom of tunnel con- crete (feet),	—	27.40
Average width of tunnel excavation (feet),	—	7.00
Volume of trench excavation per linear foot (cubic yards), . . .	3.00	5.40
Volume of tunnel excavation per linear foot (cubic yards), . . .	—	2.00
Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below masonry, back-filling, etc., to completion of work,	\$5 60	\$9 46
Approximate cost of tunnel excavation per linear foot, including excavation and refilling below masonry, back-filling, etc., to completion of work,	—	12 00

* The above-named State assistants have been employed for part of the time only on Section 15.

Character of Excavation. — For the first 60 feet, 2 feet street surfacing, clay, sand and gravel to grade; for the next 180 feet, 2 feet street surfacing, 4 feet sand, clay and gravel with ledge in the bottom; then for 272 feet, 2 feet surfacing, 4 feet sand, then sand, gravel and boulders to grade; for the next 356 feet, street surfacing, 2 feet sand, gravel, and boulders on top of ledge varying in depth from 1 to 9 feet; then for the next 738 feet, 1 foot street surfacing, 1 foot loam, followed by sand, gravel, clay and boulders to grade; for the next 174 feet, 1 foot filling, 2 feet sandy loam and gravel, 7 feet sand and gravel, then sand, gravel, clay and boulders with ledge in the bottom; then for 191 feet, street filling, 1 foot sandy loam, 6 feet coarse sand, then sand, gravel, clay and boulders with ledge in the bottom. The 499.30 feet of tunnel was through ledge.

Masonry.

Contract prices : —

Brickwork, American cement mortar, per cubic yard (trench),	. .	\$12 50
Brickwork, American cement mortar, per cubic yard (tunnel),	. .	15 00
Brickwork, Portland cement mortar, per cubic yard (trench),	. .	14 00
Brickwork, Portland cement mortar, per cubic yard (tunnel),	. .	16 00
Concrete, American cement mortar, per cubic yard (trench),	. .	5 00
Concrete, American cement mortar, per cubic yard (tunnel),	. .	6 00
Concrete, Portland cement mortar, per cubic yard (trench),	. .	7 00
Concrete, Portland cement mortar, per cubic yard (tunnel),	. .	8 00

Diameters of underdrain laid and length of each size : —

6-inch,	. . . . .	1,505.30 feet.
8-inch,	. . . . .	884.00 “
10-inch,	. . . . .	64.00 “

Approximate cost of masonry per linear foot of trench, including underdrain, tarred paper, etc., to completion of work, \$4.20.

Approximate cost of masonry per linear foot of tunnel, including underdrain, tarred paper, etc., to completion of work, \$6.59.

Length of masonry completed (trench),	. . . . .	1,971.00 feet.
Length of masonry completed (tunnel),	. . . . .	499.30 “

Masonry begun in trench April 21, 1896; finished Nov. 21, 1897.

Masonry begun in tunnel Oct. 26, 1896; finished Dec. 22, 1896.

Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, to completion of work, \$12.72.

NOTE. — The information regarding Section 15 following this note relates solely to the year ending Sept. 30, 1897. For a description of the work performed prior to this year, see the eighth annual report.

Excavation.

		Opening No. 3.
Character of opening,	. . . . .	Tunnel.
Number of tunnel headings,	. . . . .	Two.
Date of starting,	. . . . .	July 28, 1896.
Points of continuing from last year's work,		About opposite the centre line of Holmfield Avenue and about 176 feet west of Holmfield Avenue.
Points of ending,	. . . . .	About 2,209 feet from beginning of section, going west; 1,971 feet from beginning of section, going east.
Date of finishing,	. . . . .	Oct. 20, 1896.
Length,	. . . . .	62 feet.
Ordinary progress per week,	. . . . .	24 feet.
Appliances used,	. . . . .	Steam derrick.
Size of gang ordinarily employed,	. . . . .	12 men.

The ground-water from the excavation was raised by a 6-inch centrifugal pump located at a well about 1,400 feet from the beginning of the section ; pulsometers were used at the shaft at the end of the section near Wachusett Street and near Holmfield Avenue.

Foundation. — The open-cut excavation was generally in sand, gravel, boulders and ledge ; the tunnel excavation was in rock. In both the trench and tunnel work, an invert of American concrete, about 6 inches in thickness on the bottom and sides, was built, on which was laid a Portland brick invert.

Surplus Material. — The surplus material from the excavations has been used in filling low lands adjacent to the line of the sewer. A portion of the surplus rock has been used in road-building near the sewer line.

SECTION 16 (NEPONSET VALLEY SYSTEM), HYDE PARK.

Location. — From a point in River Street about 20 feet east of Wachusett Street, extending south-westerly through River Street, across the New England Railroad and railroad property, then into River Street about opposite Radcliffe Road, extending through River Street to a point about 620 feet west of Wood Avenue.

Diameters of sewers and length of each size : —

4 feet 6 inches by 4 feet 7 inches,	. . . . .	1,710.00 feet.
4 feet 2 inches by 4 feet 3 inches,	. . . . .	669.29 “

Contractor. — Harry P. Nawn of Roxbury, Mass. Mr. Nawn has acted as superintendent.

Contractor's Principal Foremen. — William Hall, Peter Mally.

State Assistants.*

- Assistant Engineer : C. Barton Pratt.
Inspectors : Michael F. Garra, S. B. Horton, Charles G. Waitt, H. M. Woodward, George F. Greenlaw.
Transitmen : Principal — Henry Cleary, G. E. Stratton, Charles Kincaid.
Assistant — Walter Cleary, M. F. Sanborn.

Trench and Tunnel.

	4 Feet 6 Inches by 4 Feet 7 Inches Sewer.	4 Feet 2 Inches by 4 Feet 3 Inches Sewer.
Length of trench excavated to bottom of underdrain (feet), . . .	1,247.00	669.29
Length of tunnel excavated to bottom of underdrain (feet), . . .	463.00	—
Average depth of trench excavation to bottom of concrete (feet),	26.50	22.20
Greatest depth of trench excavation to bottom of concrete (feet),	29.00	27.00
Average width, top of trench (feet),	9.00	8.60
Average width, bottom of trench (feet),	7.10	6.60

* The above-named State assistants have been employed for part of the time only on Section 16.

Trench and Tunnel — Concluded.

	4 Feet 6 Inches by 4 Feet 7 Inches Sewer.	4 Feet 2 Inches by 4 Feet 3 Inches Sewer.
Average depth from surface of ground to bottom of tunnel concrete (feet),	27.90	-
Greatest depth from surface of ground to bottom of tunnel concrete (feet),	34.40	-
Average width of tunnel excavation (feet),	7.20	-
Volume of trench excavation per linear foot (cubic yards), . .	7.90	5.80
Volume of tunnel excavation per linear foot (cubic yards), . .	1.80	-
Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below masonry, back-filling, etc., to completion of work,	\$10 90	\$12 45
Approximate cost of tunnel excavation per linear foot, including excavation and refilling below masonry, back filling, etc., to completion of work,	15 10	-

Character of Excavation. — From a point at the beginning of the section in River Street about 20 feet east of Wachusett Street, the excavation was by tunnel through ledge for a distance of 207 feet; then open cut through sand and gravel on top to ledge from 1 to 27 feet in depth and for a distance of 280 feet; then open cut with sand, gravel and boulders for 43 feet; tunnel under the New England Railroad tracks near River-street station for 118 feet with sand, gravel and boulders; open cut for 142 feet through 2 feet loam, 8 feet sand and gravel, then fine sand to grade; tunnel for 84 feet with sand, gravel and boulders; open cut for 138 feet with 2 feet street surfacing, 2 feet filling, 2 feet loam, 8 feet sand and gravel, then fine sand to grade; tunnel for 54 feet under the Norfolk Suburban Street Railroad through fine sand. For the next 900 feet, an open cut with 2 feet street surfacing, 5 feet filling, then sand and gravel with boulders to grade. The remaining 413 feet were excavated through 2 feet surfacing, then sand, gravel and boulders to ledge, averaging 10 feet in depth.

Masonry.

Contract prices: —

Brickwork, American cement mortar, per cubic yard,	\$12 50
Brickwork, Portland cement mortar, per cubic yard,	14 00
Concrete, American cement mortar, per cubic yard,	5 00
Concrete, Portland cement mortar, per cubic yard,	7 00

Diameters of underdrain laid and length of each size: —

6-inch,	721 feet.
8-inch,	1,658 "

Approximate cost of masonry per linear foot of trench and tunnel, including underdrain, tarred paper, etc., to completion of work, \$6.60.

Length of masonry completed (trench),	1,916.29 feet.
Length of masonry completed (tunnel),	463.00 "

Masonry begun in trench May 30, 1896; finished April 27, 1897.

Masonry begun in tunnel June 23, 1896; finished March 16, 1897.

Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, to completion of work, \$19.96.

NOTE. — The information regarding Section 16 following this note relates solely to the year ending Sept. 30, 1897. For a description of the work performed prior to this year, see the eighth annual report.

Excavation.

	Opening No. 6.	Opening No. 7.	Opening No. 8.	Opening No. 9.
Character of opening,	Open cut,	Open cut,	Open cut,	Tunnel.
Number of tunnel headings, . .	-	-	-	One.
Date of starting,	Sept. 3, 1896,	Oct. 1, 1896,	Oct. 5, 1896,	Feb. 11, 1897.
Point of continuing from last year's work (Opening No. 6), and points of beginning (openings Nos. 7, 8 and 9).	About 98 feet west from Wood Avenue in River Street.	About 40 feet from westerly side of Radcliffe Road in River Street.	About opposite westerly side of Wood Avenue in River Street.	About 40 feet east of Blake Street in River Street.
Point of ending,	About 620 feet west of Wood Avenue in River Street.	About 178 feet from westerly side of Radcliffe Road in River Street.	About 40 feet east of Blake Street in River Street.	About 94 feet east of Blake Street in River Street.
Date of finishing,	April 18, 1897,	Nov. 18, 1896,	Feb. 25, 1897,	March 5, 1897.
Length,	547 feet,	138 feet,	667 feet,	54 feet.
Ordinary progress per week, . .	23 feet,	20 feet,	48 feet,	14 feet.
Appliances used,	Carson Trench Machine,	Steam derrick,	Carson Trench Machine,	Steam derrick.
Size of gang ordinarily employed,	18 men,	18 men,	17 men,	7 men.

A 6-inch Knowles pump located at a well in the vicinity of Wood Avenue handled the ground-water.

Delay. — Work on this section was suspended for 35 days, from Dec. 4, 1896, to Jan. 8, 1897, inclusive, because of a claim made by the Tileston & Hollingsworth Company that the sewer operations had damaged one of the chimneys of their Mattapan Mills. It was found that the brickwork of the core and outer shell had been bonded in such a manner as to produce a crack when the chimney expanded. A joint report of three experts established that the cause of the trouble was primarily very faulty workmanship in the construction of the chimney. The chimney was repaired at the expense of the contractor who built it.

Foundation. — Between Wood Avenue and Blake Street, where the soil in the bottom of the trench was of running sand, it was found necessary to excavate a foot below the bottom of the masonry and refill with gravel; elsewhere the bottom excavation was in sand, gravel and ledge. Generally an American concrete invert, 6 inches in depth on the bottom and 8 inches in thickness at the springing line, was built, with a 4-inch invert of Portland brick masonry.

Difficulties. — Under the railroad, between Radcliffe Road and Blake Street, a very lively spring within the line of the trench occasioned some trouble. At this point a Portland concrete invert reinforced by side-walls of Portland brick masonry was built.

Miscellaneous. — To avoid a large water pipe on the southerly side of River Street, the sewer line was moved to the northerly side of the street, between Radcliffe Road and the end of the section.

Surplus Material. — The surplus material has been used in filling low lands adjacent to the line of the sewer. The surplus rock has been used in road-building in the vicinity.

SECTION 17 (NEPONSET VALLEY SYSTEM), HYDE PARK.

Location. — From a point in River Street, Hyde Park, near Mattapan Mills, about 620 feet west of Wood Avenue, extending westerly through River Street and private lands, along Neponset River to a point near the junction of Metropolitan Avenue and Pierce Street.

Diameter and length of sewer: —

4 feet 3 inches by 4 feet 4 inches, 1,768.72 feet.

Contractors. — George R. Newman & Co. of Providence, R. I.

Contractors' Superintendent. — Charles L. Mowry.

Contractors' Principal Foreman. — William Mahoney.

State Assistants.*

Assistant Engineer : C. Barton Pratt.
Inspectors : John D. Collins, Michael F. Garra, George F. Greenlaw.
Transitmen : Principal — Henry Cleary, G. E. Stratton, Charles Kincaid.
Assistant — Walter Cleary, M. F. Sanborn.

Trench and Tunnel.

	4 Feet 3 Inches by 4 Feet 4 Inches Sewer.
Length of trench excavated to bottom of underdrain (feet), . .	1,282.72
Length of tunnel excavated to bottom of underdrain (feet), . .	486.00
Average depth of trench excavation to bottom of concrete (feet), .	16.00
Greatest depth of trench excavation to bottom of concrete (feet), .	31.30
Average width, top of trench (feet),	7.60
Average width, bottom of trench (feet),	7.20
Average depth from surface of ground to bottom of tunnel concrete (feet),	30.40
Greatest depth from surface of ground to bottom of tunnel concrete (feet),	32.60
Average width of tunnel excavation (feet),	5.30
Volume of trench excavation per linear foot (cubic yards), . .	4.40
Volume of tunnel excavation per linear foot (cubic yards), . .	1.50
Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below masonry, back-filling, etc., to completion of work, \$9.35.	
Approximate cost of tunnel excavation per linear foot, including ex- cavation and refilling below masonry, back-filling, etc., to com- pletion of work, \$12.75.	

Character of Excavation. — The 486 feet of tunnel in River Street at beginning of section was through very hard ledge. The open cut which began in proposed street in Sumner estate was through about 1.5 feet loam, then sand and gravel with ledge to grade. The ledge was very irregular, varying in depth from 1 to 19 feet for a distance of 711 feet. The last 85 feet were excavated through loam, then sand, gravel and clay to grade.

Masonry.

Contract prices :—	
Brickwork, American cement mortar, per cubic yard (trench), . .	\$12 50
Brickwork, American cement mortar, per cubic yard (tunnel), . .	13 85
Brickwork, Portland cement mortar, per cubic yard (trench), . .	14 00
Brickwork, Portland cement mortar, per cubic yard (tunnel), . .	15 65
Concrete, American cement mortar, per cubic yard (trench), . .	5 00
Concrete, American cement mortar, per cubic yard (tunnel), . .	5 85
Concrete, Portland cement mortar, per cubic yard (trench), . .	6 75
Concrete, Portland cement mortar, per cubic yard (tunnel), . .	7 50
Diameters of underdrain laid and length of each size :—	
4-inch,	486 feet.
6-inch,	295 “
8-inch,	988 “
Approximate cost of masonry per linear foot of trench, including under- drain, tarred paper, etc., to completion of work, \$6.01.	
Approximate cost of masonry per linear foot of tunnel, including under- drain, tarred paper, etc., to completion of work, \$6.94.	

* The above-named State assistants have been employed a part of the time only on Section 17.

Length of masonry completed (trench), 1,282.72 feet.
 Length of masonry completed (tunnel), 486.00 "
 Masonry begun in trench June 29, 1896; finished Jan. 30, 1897.
 Masonry begun in tunnel Feb. 1, 1897; finished April 14, 1897.
 Approximate cost of section per linear foot of excavation and masonry,
 including labor, material, inspection and miscellaneous items, to
 completion of work, \$19.33.

NOTE. — The information regarding Section 17 following this note relates solely to the year ending Sept. 30, 1897. For a description of the work performed prior to this year, see the eighth annual report.

Excavation.

	Opening No. 1.	Opening No. 2.
Character of opening,	Open cut,	Tunnel.
Number of tunnel headings,	-	Two.
Date of starting,	May 14, 1896,	May 19, 1896.
Point of continuing from last year's work,	Near Neponset River in estate of Caroline E. Mowry.	About 86 feet each way from shaft; shaft 230 feet from beginning of section.
Point of ending,	Near the junction of Metropolitan Avenue and Pierce Street.	At the lower end of section and at a point 486 feet from beginning of section in proposed street in Sumner estate.
Date of finishing,	Nov. 16, 1896,	Feb. 4, 1897.
Length,	1,282.72 feet,	486 feet.
Ordinary progress per week,	50 feet,	14 feet.
Appliances used,	Steam derrick and Brown Trench Machine.	Steam derrick.
Size of gang ordinarily employed,	45 men,	15 men.

The ground-water has been taken care of by a 4-inch centrifugal pump located in a well near the westerly line of the Field estate and a No. 3 pulsometer in a shaft in River Street.

Delay. — Operations on this section were suspended for 27 days, Dec. 4 to Dec. 31, 1896, inclusive, because of a complaint of the Tileston & Hollingsworth Company, in which it was alleged that our blasting operations had damaged one of the chimneys of their Mattapan Mills. This complaint is further referred to in report on Section 16.

Foundation. — The bottom of the trench was principally of ledge. A 4-inch brick invert has been laid in a bed of American concrete, 6 inches in depth on the bottom and from 6 to 8 inches in thickness at the springing line, for the whole section. The arch is of 8-inch American brick masonry.

Precautions. — The sewer arch was reinforced with concrete for about 112 feet at the end of the section, where the sewer is built through overflowed area near the Neponset River.

Surplus Material. — The surplus material from the excavations has been used in filling low lands adjacent to the line of the sewer.

SECTION 18 (NEPONSET VALLEY SYSTEM), HYDE PARK.

Location. — From near the junction of Metropolitan Avenue and Pierce Street, Hyde Park, south-westerly through private and railroad lands, through Station Street to a point in Walnut Street about 400 feet south-west of Fairmount Avenue.

Diameter and length of sewer : —

4 feet 3 inches by 4 feet 4 inches, 2,719 feet.

Contractors. — Troy Public Works Company of Troy, N. Y.

Contractors' Superintendent. — The work was superintended by Mr. M. McDonough, a member of the above-named corporation.

Contractors' Principal Foremen. — John McKenzie, James J. Cook, Walter Ferguson, John Jefferson.

*State Assistants.**

Assistant Engineer : Seth Peterson.

Inspector : Caleb Kimball.

Transitmen : Principal (in charge of lines and grades) — S. G. Packard.

Principal (in charge of records) — J. L. Lee, Jr.

Assistant — L. D. Hatch, Harry Kincaid.

Trench and Tunnel.

	4 Feet 3 Inches by 4 Feet 4 Inches Sewer.
Length of trench excavated to bottom of underdrain (feet), . . .	2,630.00
Length of tunnel excavated to bottom of underdrain (feet), . . .	89.00
Average depth of trench excavation to bottom of underdrain (feet), .	16.50
Greatest depth of trench excavation to bottom of underdrain (feet), .	24.00
Average width, top of trench (feet),	7.70
Average width, bottom of trench (feet),	6.70
Average depth from surface of ground to bottom of tunnel excavation (feet),	23.00
Greatest depth from surface of ground to bottom of tunnel excavation (feet),	23.00
Average width of tunnel excavation (feet),	8.20
Volume of trench excavation per linear foot (cubic yards), . . .	4.80
Volume of tunnel excavation per linear foot (cubic yards), . . .	2.50
Approximate cost per linear foot, including sheeting left in, excava- tion and refilling below masonry, back-filling, etc., to completion of work, \$7.75.	

Character of Excavation. — At the beginning of the section the formation consisted of 2 feet peat, then sand, gravel and boulders to grade. Ledge was encountered in the bottom about 20 feet from the beginning. Four hundred and fifty feet from the beginning, 1 foot sand, 2 feet gravel, 1 foot peat, 3 feet gravel, ledge to grade. The ledge ran out near the foot of West Street. From West Street for the next 600 feet, 2 feet peat, then sand, gravel and clay to grade; next 150 feet, 2 feet peat, 2 feet clay, fine wet sand to grade; at foot of Walter Street, 2 feet peat, 3 feet sand and gravel, fine wet sand to grade; opposite New England Railroad station, 8 inches gravel, 3 feet sand, 5 feet loamy gravel, 2 feet clay, 1 foot peat, yellow sandy clay to grade; Station Street, 200 feet south of Fairmount Avenue, 1 foot surfacing, 8 feet filling (sand and gravel), 3 feet peat, 6 feet sand and clay, running sand below; under the railroad tracks near Walnut Street, sand and gravel with a little clay.

* The above-named State assistants have been employed for part of the time only on Section 18.

Masonry.

Contract prices : —

Brickwork, American cement mortar, per cubic yard,	. . . . .	\$12 50
Brickwork, Portland cement mortar, per cubic yard,	. . . . .	14 50
Concrete, American cement mortar, per cubic yard, .	. . . . .	5 50
Concrete, Portland cement mortar, per cubic yard, .	. . . . .	7 00

Diameters of underdrain laid and length of each size : —

4-inch,	. . . . .	100 feet.
6-inch,	. . . . .	500 “
8-inch,	. . . . .	1,248 “
10-inch,	. . . . .	874 “

Approximate cost of masonry per linear foot of trench and tunnel, including underdrain, tarred paper, etc., to completion of work, \$6.60.

Length of masonry completed (trench),	. . . . .	2,630 feet.
Length of masonry completed (tunnel),	. . . . .	89 “

Masonry begun in trench May 22, 1896; finished Nov. 9, 1896.

Masonry begun in tunnel Oct. 17, 1896; finished Nov. 7, 1896.

Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, to completion of work, \$14.80.

NOTE. — The information regarding Section 18 following this note relates solely to the year ending Sept. 30, 1897. For a description of the work performed prior to this year, see the eighth annual report.

Excavation.

		Opening No. 4.
Character of opening,	. . . . .	Tunnel.
Number of tunnel headings,	. . . . .	One.
Date of starting,	. . . . .	Aug. 31, 1896.
Point of continuing from last year's work,	. . . . .	93 feet from end of section.
Point of ending,	. . . . .	134 feet from end of section.
Date of finishing,	. . . . .	Oct. 16, 1896.
Length,	. . . . .	41 feet.
Ordinary progress per week,	. . . . .	20 feet.
Appliances used,	. . . . .	Derrick and wheelbarrows.
Size of gang ordinarily employed,	. . . . .	10 men.

The ground-water was raised by a 6-inch centrifugal pump located about 600 feet north of the New England Railroad station, which was kept in continuous operation until the completion of the work. In addition to this, a pulsometer located in a well on Section 19, about 20 feet beyond the end of Section 18, assisted in the disposal of the ground-water for three or four weeks while operations were in progress in the tunnel. The estimated greatest rate of pumping in 24 hours was 400,000 gallons.

Foundation. — The bottom of the excavation consisted of sand and gravel, which ran freely. A concrete invert was used throughout the section.

Difficulties. — The tunnel under the railroad was driven with great caution and at a slow rate, owing to the sand and gravel running very freely. This tunnel was back-filled solidly to the lagging with American concrete.

SECTION 19 (NEPONSET VALLEY SYSTEM), HYDE PARK.

Location. — From a point in Walnut Street, Hyde Park, about 400 feet south-west of Fairmount Avenue, extending south-westerly through Walnut Street and private lands, under New York, New Haven & Hartford Railroad, to Business Street and to a point in Business Street about 625 feet south-west of Barry Place.

Diameters of sewers and length of each size : —

4 feet 3 inches by 4 feet 4 inches,	1,290 feet.
4 feet by 4 feet 1 inch,	1,361 “

Contractors. — Geo. S. Good & Co. of Lock Haven, Pa.
Contractors' Superintendent. — F. C. Hitchcock.
Contractors' Principal Foremen. — Thomas Ferguson, Michael Coleman.

State Assistants.*

Assistant Engineer : Seth Peterson.
Inspectors : John Craib, J. E. Savage.
Transitmen : Principal (in charge of lines and grades) — S. G. Packard.
Principal (in charge of records) — J. L. Lee, Jr.
Assistant — L. D. Hatch, Harry Kincaid, B. W. Torrey.

Trench and Tunnel.

	4 Feet 3 Inches by 4 Feet 4 Inches Sewer.	4 Feet by 4 Feet 1 Inch Sewer.
Length of trench excavated to bottom of underdrain (feet), . . .	1,290.00	1,264.00
Length of tunnel excavated to bottom of underdrain (feet), . . .	—	97.00
Average depth of trench excavation to bottom of underdrain (feet),	18.30	15.00
Greatest depth of trench excavation to bottom of underdrain (feet),	25.00	18.00
Average width, top of trench (feet),	8.50	7.00
Average width, bottom of trench (feet),	6.00	6.50
Average depth from surface of ground to bottom of tunnel under- drain (feet),	—	18.00
Greatest depth from surface of ground to bottom of tunnel under- drain (feet),	—	18.00
Average width of tunnel excavation (feet),	—	6.60
Volume of trench excavation per linear foot (cubic yards), . . .	5.00	4.50
Volume of tunnel excavation per linear foot (cubic yards), . . .	—	1.50
Approximate cost of trench and tunnel per linear foot, including sheeting left in, excavation and refilling below masonry, back- filling, etc., to completion of work,	\$4 90	\$4 00†

* The above-named State assistants have been employed for part of the time only on Section 19.
† No price bid for tunnel work by contractor.

Character of Excavation.—At the beginning of section, 1 foot street surfacing, then sand, gravel and clay to a depth of about 18 feet, then mixture of clay and sand to grade. At Bridge Street, 1 foot surfacing, 4 feet gravel and sand, ledge to grade. Opposite corner Bleakie's Mills, 1 foot loam, 6 feet loam and gravel, 5 feet hard clay and gravel, hard-pan below. Barry Place, 1 foot surfacing, 6 feet gravel, 3 feet fine sand, gravel below. At a point about 100 feet from Barry Place in Business Street, 6 inches macadam, 2 feet sand, gravel and loam, 2 feet peat, fine running sand to grade. At end of section, 6 inches macadam, clay, gravel and loam to grade.

Masonry.

Contract prices:—

Brickwork, American cement mortar, per cubic yard,	. . . . .	\$12 00
Brickwork, Portland cement mortar, per cubic yard,	. . . . .	14 00
Concrete, American cement mortar, per cubic yard,	. . . . .	6 00
Concrete, Portland cement mortar, per cubic yard,	. . . . .	7 50

Diameters of underdrain laid and length of each size:—

6-inch,	. . . . .	315 feet.
8-inch,	. . . . .	813 “
10-inch,	. . . . .	1,519 “

Approximate cost of masonry per linear foot of trench and tunnel, including underdrain, tarred paper, etc., to completion of work, \$5.80.

Length of masonry completed (trench),	. . . . .	2,554 feet.
Length of masonry completed (tunnel),	. . . . .	97 “

Masonry was begun in trench June 12, 1896; finished Jan. 4, 1897.

Masonry was begun in tunnel Dec. 3, 1896; finished Jan. 1, 1897.

Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, to completion of work, \$10.40.

NOTE.—The information regarding Section 19 following this note relates solely to the year ending Sept. 30, 1897. For a description of the work performed prior to this year, see the eighth annual report.

Excavation.

	Opening No. 1.	Opening No. 2.	Opening No. 3.	Opening No. 4.
Character of opening,	Open cut,	Open cut,	Open cut,	Tunnel.
Number of tunnel headings, . .	-	-	-	One.
Date of starting,	May 18, 1896,	Sept. 16, 1896,	Oct. 2, 1896,	Nov. 17, 1896.
Point of beginning or point of continuing from last year's work.	About 150 feet west of Walnut Place.	In Barry Place, just west of railroad tracks.	In Business Street, about 200 feet south of Barry Place.	Westerly side New York, New Haven & Hartford Railroad tracks.
Point of ending,	East side of New York, New Haven & Hartford Railroad tracks.	Business Street, about 200 feet south of Barry Place.	End of section,	Easterly side New York, New Haven & Hartford Railroad tracks.
Date of finishing,	Nov. 18, 1896,	Nov. 13, 1896,	Nov. 18, 1896,	Dec. 11, 1896.
Length,	636 feet,	351 feet,	430 feet,	95 feet.
Ordinary progress per week, . .	100 feet,	70 feet,	80 feet,	25 feet.
Appliances used,	Carson Trench Machine,	Derrick,	Carson Trench Machine,	Wheelbarrows.
Size of gang ordinarily employed,	40 men,	25 men,	30 men,	8 men.

The ground-water was raised by a 6-inch centrifugal pump near Bleakie's Mill, a 2-inch pump near the railroad at Barry Place and a pulsometer in Business Street, 150 feet south of Barry Place. The estimated maximum rate of pumping in 24 hours was 500,000 gallons.

Foundation.—For a distance of about 350 feet on Business Street, south of Barry Place, where the formation consisted of fine wet sand, it was necessary to excavate from 6 to 12 inches below grade and refill with gravel. At all other points the excavation has been in sand, gravel, clay and some ledge.

An invert of American concrete has been used throughout the greater portion of the section.

Miscellaneous.—Under the New York, New Haven & Hartford Railroad tracks the arch of the sewer in tunnel was back-filled to the lagging with American concrete.

The line of the sewer on Business Street was changed to the easterly side of the street.

Surplus Material.—The surplus excavated material has been used in filling adjacent low lands.

SECTION 20 (NEPONSET VALLEY SYSTEM), HYDE PARK.

Location.—From a point in Business Street, Hyde Park, about 625 feet south-west of Barry Street, extending south-westerly through Business and West River streets to a point about 25 feet east of Atherton Street.

Diameter and length of sewer:—

4 feet by 4 feet 1 inch, 3,212 feet.

Contractors.—George S. Good & Co. of Lock Haven, Pa.

Contractors' Superintendent.—F. C. Hitchcock.

Contractors' Principal Foreman.—H. H. DeGroot.

State Assistants.*

Assistant Engineer: Seth Peterson.

Inspectors: Geo. A. Chase, John Craib.

Transitmen: Principal (in charge of lines and grades)—S. G. Packard.

Principal (in charge of records)—J. L. Lee, Jr.

Assistant—L. D. Hatch, Harry Kincaid, B. W. Torrey.

Trench.

	4 Feet by 4 Feet 1 Inch Sewer.
Length of trench excavated to bottom of underdrain (feet), . . .	3,212.00
Average depth of trench excavation to bottom of underdrain (feet), .	16.80
Greatest depth of trench excavation to bottom of underdrain (feet), .	20.00
Average width, top of trench (feet),	8.00
Average width, bottom of trench (feet),	6.70
Volume of trench excavation per linear foot (cubic yards), . . .	4.50
Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below masonry, back-filling, etc., to com- pletion of work, \$3.85.	

* The above-named State assistants have been employed for part of the time only on Section 20.

Character of Excavation.— For the first 250 feet, 6 inches macadam, 1 foot gravel, 8 feet sand and gravel, then clay and gravel to grade. At the beginning of the original opening, 250 feet from beginning of section, 8 inches street surfacing, 8 feet sand and gravel, then sand and gravel with considerable clay to grade. At a point 100 feet from Business Street, on River Street, 1 foot surfacing, 7 feet sand and gravel, fine sand below. At Ellis Street, 1 foot surfacing, 8 feet sand and gravel, then sand and clay to grade. Two hundred feet south of Church Street, 1 foot surfacing, 6 feet gravel, 1 foot sand and clay, then hard-pan to grade. Opposite Readville Street, 1 foot macadam, 5 feet coarse gravel, 5 feet gravel and sand, fine sand to grade, the sand in the bottom of the excavation being quite wet. Three hundred feet beyond Readville Street, 1 foot surfacing, 4 feet gravel and sand, fine running sand to grade, this formation existing to the end of the section.

Masonry.

Contract prices :—

Brickwork, American cement mortar, per cubic yard,	\$12 00
Brickwork, Portland cement mortar, per cubic yard,	14 00
Concrete, American cement mortar, per cubic yard,	6 00
Concrete, Portland cement mortar, per cubic yard,	7 50

Diameters of underdrain laid and length of each size :—

6-inch,	375 feet.
10-inch,	2,887 “

Approximate cost of masonry per linear foot of trench, including underdrain, tarred paper, etc., to completion of work, \$6.15.

Length of masonry completed, 3,212 feet.

Masonry was begun in trench June 19, 1896 ; finished Feb. 7, 1897.

Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, to completion of work, \$10.20.

NOTE.—The information regarding Section 20 following this note relates solely to the year ending Sept. 30, 1897. For a description of the work performed prior to this year, see the eighth annual report.

Excavation.

	Opening No. 1.	Opening No. 2.	Opening No. 3.
Character of opening, .	Open cut, . . .	Open cut, . . .	Open cut.
Date of starting, . .	May 22, 1896, . .	Nov. 17, 1896, . .	Nov. 18, 1896.
Point of beginning or point of continuing from last year's work.	200 feet south-west of Church Street.	400 feet west of Readville Street.	At beginning of section.
Point of ending, . .	About 400 feet west of Readville Street.	End of section, .	250 feet from beginning of section.
Date of finishing, . .	Dec. 18, 1896, . .	Feb. 1, 1897, . .	Dec. 11, 1896.
Length,	976 feet, . . .	341 feet, . . .	250 feet.
Ordinary progress per week.	100 feet, . . .	48 feet, . . .	60 feet.
Appliances used, . .	Carson Trench Machine.	Carson Trench Machine.	Carson Trench Machine.
Size of gang ordinarily employed.	30 men, . . .	30 men, . . .	25 men.

A 6-inch centrifugal pump was used between Ellis and Church streets, and later at a point 100 feet north of Readville Street. Another 6-inch centrifugal pump and a pulsometer were used at the beginning of Opening No. 2. The estimated maximum rate of pumping in 24 hours was 800,000 gallons.

Foundation. — The bottom of the trench was excavated in clay and gravel to fit the invert of the sewer for a distance of approximately 270 feet between Church and Readville streets.

For 1,100 feet of the section fine running sand was encountered, which was excavated to a depth varying from 8 inches to 2 feet below grade and refilled with gravel. At all other points the bottom excavation was in sand and gravel, occasionally mixed with clay.

Difficulties. — For the last 340 feet of the section the bottom excavation was in fine running sand. The street settled some, breaking a gas pipe near the excavation. At a point about 130 feet from the end of the section the underdrain became clogged with the fine sand. A pump well was excavated near this place, which caused the street to settle about 6 feet. Thirty-four feet of underdrain and concrete invert put in near this point were abandoned. For a distance of 160 feet the sewer was raised $2\frac{1}{2}$ feet, passing this area of very fine wet sand; this was made possible by moving the location of a step man-hole. Through the low-level trench in running sand the concrete invert was built of Portland cement, and in the high-level trench through the same formation the thickness of the American concrete was increased 2 inches.

Miscellaneous. — A slight change was made in the centre line for the last 100 feet of the section, where the trench had moved considerably.

Surplus Material. — Much of the surplus material from the excavations has been used in filling low lands adjacent to the sewer line; some sand and gravel was used in concrete.

SECTION 21 (NEPONSET VALLEY SYSTEM), HYDE PARK AND DEDHAM.

Location. — From a point in River Street, Hyde Park, about 25 feet east of Atherton Street, extending westerly through public and private lands along the northerly bank of Mother Brook to a point in Dedham about 1,000 feet west of the town line between Hyde Park and Dedham.

Diameter and length of sewer:—

4 feet by 4 feet 1 inch, 3,599 feet.

Contractors. — Mathers & Sullivan of Washington, D. C. The work was superintended by Mr. E. A. Mathers, a member of the firm.

Contractors' Principal Foremen. — Richard Morrissey, William Sullivan.

State Assistants.*

Assistant Engineer : Seth Peterson.
Inspector : H. M. Woodward.
Transitmen : Principal (in charge of lines and grades) — J. L. Brown.
Principal (in charge of records) — Geo. F. Chase.
Assistant — A. B. Cleaveland, F. W. Crispin.

Trench.

	4 Feet by 4 Feet 1 Inch Sewer.
Length of trench excavated to bottom of underdrain (feet), . . .	3,599.00
Average depth of trench excavation to bottom of underdrain (feet), .	12.50
Greatest depth of trench excavation to bottom of underdrain (feet), .	19.50
Average width, top of trench (feet),	6.70
Average width, bottom of trench (feet),	6.50
Volume of trench excavation per linear foot (cubic yards), . . .	2.90
Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below masonry, back-filling, etc., to com- pletion of work, \$3.30.	

Character of Excavation. — For the first 150 feet of the section about 6 inches of gravel, street surfacing, sand, gravel and clay to about water line; fine wet sand below. Then, for a distance of about 300 feet, 1½ feet loam, 2 feet sand and gravel, fine wet sand below; for the next 1,100 feet, 1 foot loam, sand and gravel below; for the next 300 feet, ledge starts from about water line and runs to within a foot of surface, then drops back to grade; sand and gravel above ledge; beyond ledge, about 1 foot of loam, fine sand to grade.

Masonry.

Contract prices : —	
Brickwork, American cement mortar, per cubic yard,	\$10 35
Brickwork, Portland cement mortar, per cubic yard,	11 50
Concrete, American cement mortar, per cubic yard,	5 75
Concrete, Portland cement mortar, per cubic yard,	6 75

Diameters of underdrain laid and length of each size : —	
6-inch,	423 feet.
8-inch,	1,636 “
10-inch,	1,531 “

Approximate cost of masonry per linear foot of trench, including underdrain, tarred paper, etc , to completion of work, \$5.70.
Length of masonry completed (trench), 3,599 feet.
Masonry begun in trench July 27, 1896; finished May 2, 1897.
Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, to completion of work, \$9.20.

NOTE. — The information regarding Section 21 following this note relates solely to the year ending Sept. 30, 1897. For a description of the work performed prior to this year, see the eighth annual report.

* The above-named State assistants have been employed for a part of the time only on Section 21.

Excavation.

	Opening No. 1.	Opening No. 2.
Character of opening, . . .	Open cut,	Open cut.
Date of starting,	July 7, 1896,	April 7, 1897.
Point of beginning or point of continuing from last year's work,	About the middle of Fairview Cemetery.	About 150 feet from beginning of section.
Point of ending,	End of section,	At the beginning of section.
Date of finishing,	Nov. 23, 1896,	April 23, 1897.
Length,	1,472 feet,	148 feet.
Ordinary progress per week, .	200 feet,	75 feet.
Appliances used,	Steam drills used on ledge; hand labor otherwise.	Hand labor.
Size of gang ordinarily employed,	100 men,	20 men.

The ground-water was raised by a 6-inch centrifugal pump near the beginning of the section, a 6-inch Worthington pump near the middle and a 2-inch Worthington pump at the end of the section. Hand-pumps were occasionally used. The estimated maximum rate of pumping in 24 hours was 800,000 gallons.

Shut-down. — Work was suspended from Dec. 20, 1896, to April 7, 1897, to avoid extra expense of construction during the winter.

Foundation. — At several points on the section fine wet sand was found. This was excavated from 3 to 8 inches below grade and replaced with gravel. The bottom excavation at all other points was in sand, gravel and ledge. A concrete invert has been built throughout the section.

Accident. — On Tuesday, Nov. 24, 1896, a staging fell, causing slight injuries to five men; Edward Truedell, a mason employed on the work, had several ribs fractured.

Miscellaneous. — The sewer line was slightly changed near the beginning of the section to make a suitable connection with Section 20.

Surplus Material. — Much of the sand and gravel was used in concrete; the remainder was levelled within the lines of taking.

SECTION 22 (NEPONSET VALLEY SYSTEM), DEDHAM.

Location. — From a point in Dedham about 1,000 feet west of the town line between Dedham and Hyde Park, extending in a north-westerly direction along the bank of Mother Brook, to a point about 550 feet north-west of Mill Lane.

Diameter and length of sewer : —
4 feet by 4 feet 1 inch, 2,404 feet.

Contractors. — Mathers & Sullivan of Washington, D. C. The work was superintended by Mr. E. A. Mathers, a member of this firm.

Contractors' Principal Foreman. — William Sullivan.

*State Assistants.**

Assistant Engineer: Seth Peterson.

Inspector: H. M. Woodward.

Transitmen: Principal (in charge of lines and grades) — J. L. Brown.

Principal (in charge of records) — Geo. F. Chase.

Assistant — A. B. Cleaveland, F. W. Crispin, B. W. Torrey.

Trench.

	4 Feet by 4 Feet 1 Inch Sewer.
Length of trench excavated to bottom of underdrain (feet), . . .	2,404.00
Average depth of trench excavation to bottom of underdrain (feet), .	15.20
Greatest depth of trench excavation to bottom of underdrain (feet), .	24.00
Average width, top of trench (feet),	11.00
Average width, bottom of trench (feet),	5.70
Volume of trench excavation per linear foot (cubic yards), . . .	5.00
Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below masonry, back-filling, etc., to com- pletion of work, \$9.35.	

Character of Excavation. — At the beginning of the section, about 1 foot loam, sand and gravel to grade; this same formation existed from a point about 240 feet east of Norfolk Mills Dam to about 80 feet east of it; also for a length of about 40 feet towards the end of the section. The remainder of the section has been in ledge, running from water line to 17 feet above, overlaid with sand and gravel.

Masonry.

Contract prices: —

Brickwork, American cement mortar, per cubic yard,	\$10 35
Brickwork, Portland cement mortar, per cubic yard,	11 50
Concrete, American cement mortar, per cubic yard,	5 75
Concrete, Portland cement mortar, per cubic yard,	6 75

Diameters of underdrain laid and length of each size: —

4-inch,	123 feet.
6-inch,	1,938 "
8-inch,	278 "

Approximate cost of masonry per linear foot of trench, including underdrain, tarred paper, etc., to completion of work, \$5.50.

Length of masonry completed, 2,404 feet.

Masonry begun in trench Aug. 6, 1896; finished June 26, 1897.

Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, to completion of work, \$15.50.

NOTE. — The information regarding Section 22 following this note relates solely to the year ending Sept. 30, 1897. For a description of the work performed prior to this year, see the eighth annual report.

Excavation.

Character of opening,	Open cut.
Date of starting,	July 13, 1896.
Points of continuing from last year's work,	About 400 feet west of Norfolk Mills Dam and about 500 feet east of it.
Points of ending,	Beginning and end of section.
Date of finishing,	June 24, 1897.
Length,	1,484 feet.
Ordinary progress per week,	60 feet.
Appliances used,	Steam drills, derricks and hand labor.
Size of gang ordinarily employed,	65 men.

* The above-named State assistants have been employed for part of the time only on Section 22.

A 6-inch and a 2-inch Worthington pump have been used in pumping the ground-water. The estimated maximum rate of pumping in 24 hours was 600,000 gallons.

Shut-down. — Operations on this section were suspended from December 23 to March 26, to avoid extreme cold weather.

Foundation. — The bottom excavation for this section has been in rock, excepting 100 feet at the beginning and 40 feet at the end, where sand and gravel were found. A concrete invert has been used throughout the section.

Difficulties. — Some difficulty was experienced in handling water from the Norfolk Mills Pond, the level of which had been raised by the construction of a new dam. The water followed the back-filling above the dam.

Accident. — John Conly, a brick-mason employed on the work, had ribs and collar-bone fractured by rock from a blast.

Surplus Material. — Much of the surplus material has been spread within the taking lines and the remainder carted away.

SECTION 23 (NEPONSET VALLEY SYSTEM), DEDHAM.

Location. — From a point on the northerly bank of Mother Brook, 550 feet north-west of Mill Lane, extending north-westerly through public and private lands along Mother Brook to a point in Colburn Street about 40 feet south-easterly of Maverick Street.

Diameter and length of sewer : —

4 feet by 4 feet 1 inch, 2,596 feet.

Contractors. — Haskin & Murphy of Charlestown, Mass.

Contractors' Superintendent. — Thomas H. Murphy, a member of the above-mentioned firm.

Contractors' Principal Foremen. — Martin McLauthlin, Henry Burke, John Clark.

State Assistants.*

Assistant Engineer : Seth Peterson.

Inspectors : George F. Greenlaw, Caleb Kimball, J. E. Savage, Chris Rasmussen, John Craib.

Transitmen : Principal (in charge of lines and grades) — J. L. Brown.

Principal (in charge of records) — Geo. F. Chase.

Assistant — A. B. Cleaveland, F. W. Crispin, B. W. Torrey.

Trench and Tunnel.

	4 Feet by 4 Feet 1 Inch Sewer.
Length of trench excavated to bottom of underdrain (feet), . .	868.00
Length of tunnel excavated to bottom of underdrain (feet), . .	1,728.00
Average depth of trench excavation to bottom of underdrain (feet), .	14.50
Greatest depth of trench excavation to bottom of underdrain (feet), .	17.60
Average width, top of trench (feet),	9.80
Average width, bottom of trench (feet),	6.00
Average depth from surface of ground to bottom of tunnel excavation (feet),	24.00

* The above-named State assistants have been employed for part of the time only on Section 23.

4 Feet by 4 Feet
1 Inch Sewer.

Greatest depth from surface of ground to bottom of tunnel excavation (feet),	29.00
Average width of tunnel excavation (feet),	6.50
Volume of trench excavation per linear foot (cubic yards),	4.20
Volume of tunnel excavation per linear foot (cubic yards),	1.80
Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below masonry, back-filling, etc., to completion of work, \$10.41.	
Approximate cost of tunnel excavation per linear foot, including excavation and refilling below masonry, back-filling, etc., to completion of work, \$10.	

Character of Excavation.— For the first 450 feet the excavation was in rock ; from this point the rock ran downwards and disappeared in about 100 feet, the material being 8 inches loam, then sand and gravel to grade for the next 250 feet ; then rock again appeared and ran to a height of 7 or 8 feet above water line, with sand and gravel above for about 70 feet. The remainder of the section was in tunnel, and the formation consisted of rock except for about 150 feet in Bussey Street, where it consisted of sand, gravel and boulders.

Masonry.

Contract prices :—	
Brickwork, American cement mortar, per cubic yard (trench), . . .	\$12 00
Brickwork, American cement mortar, per cubic yard (tunnel), . . .	14 00
Brickwork, Portland cement mortar, per cubic yard (trench), . . .	13 00
Brickwork, Portland cement mortar, per cubic yard (tunnel), . . .	15 00
Concrete, American cement mortar, per cubic yard (trench), . . .	5 00
Concrete, American cement mortar, per cubic yard (tunnel), . . .	6 00
Concrete, Portland cement mortar, per cubic yard (trench), . . .	7 50
Concrete, Portland cement mortar, per cubic yard (tunnel), . . .	8 50
Diameters of underdrain laid and length of each size :—	
4-inch,	1,600 feet.
6-inch,	685 “
8-inch,	302 “
Approximate cost of masonry per linear foot of trench, including underdrain, tarred paper, etc., to completion of work, \$5.40.	
Approximate cost of masonry per linear foot of tunnel, including underdrain, tarred paper, etc., to completion of work, \$6.20.	
Length of masonry completed (trench),	868 feet.
Length of masonry completed (tunnel),	1,728* “
Masonry was begun in trench April 24, 1897 ; finished Sept. 1, 1897.	
Masonry was begun in tunnel Nov. 13, 1896 ; finished July 23, 1897.	
Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, to completion of work, \$16.60.	

NOTE.— The information regarding Section 23 following this note relates solely to the year ending Sept. 30, 1897. For a description of the work performed prior to this year, see the eighth annual report.

* A portion of this tunnel work was paid for at trench rates.

*Excavation.**

	Opening No. 1.	Opening No. 3.	Opening No. 4.	Opening No. 5.	Opening No. 6.
Character of opening, . . .	Tunnel,	Tunnel,	Tunnel,	Tunnel,	Open cut.
Number of tunnel headings, . .	One,	Two,	Two,	Two,	-
Date of starting,	July 20, 1896,	Oct. 3, 1896,	Sept. 24, 1896,	Feb. 12, 1897,	March 25, 1897.
Point of beginning,	About 625 feet north of corner of Maverick and Colburn streets.	Colburn Street, 400 feet south of Curve Street.	Colburn Street, corner of Curve Street.	Colburn Street, 150 feet north of Bussey Street.	At beginning of section.
Points of ending,	38 feet nearer Bussey Street.	221 feet towards Curve Street; 97 feet in the opposite direction.	164 feet south of Curve Street; also at Bussey Street.	At Bussey Street; also 330 feet north of Bussey Street.	At Colburn Street, 330 feet north of Bussey Street.
Date of finishing,	Oct. 16, 1896,	Feb. 3, 1897,	April 13, 1897,	May 7, 1897,	Aug. 20, 1897.
Length,	38 feet,	318 feet,	348 feet,	348 feet,	868 feet.
Ordinary progress per week, . .	40 feet,	18 feet,	35 feet,	60 feet,	45 feet.
Appliances used,	Drills run by compressed air; elevators at shaft, wheelbarrows.	Tripod derrick, horse-power.	Tripod derrick, steam-power.	Tripod derrick, steam-power.	Cable machine for first 400 feet; balance of opening, staging.
Size of gang ordinarily employed,	17 men,	9 men,	11 men,	15 men,	22 men.

* Opening No. 2 finished last year.

The ground-water was handled by a 6-inch Worthington pump used at different points on the section; a 2-inch pump and a pulsometer were also occasionally used. The estimated maximum rate of pumping in 24 hours was 400,000 gallons.

Shut-down. — The work on the shaft at the corner of Colburn and Curve streets was suspended for about three weeks because of flooding.

Foundation. — The bottom excavation was in rock, excepting for 250 feet east of Colburn Street and 100 feet under Bussey Street, where sand and gravel were found.

A concrete invert has been used throughout the section.

Difficulties. — At the corner of Colburn and Curve streets considerable water was found. The roof of the tunnel caved in, which necessitated retimbering. At the next shaft, on Bussey Street, the water from the mill-pond came freely through the street filling. After working a month the shaft was abandoned. A new one was opened at a point 150 feet north and the sewer line moved farther away from the pond. When the heading reached a point about opposite the abandoned shaft it became flooded. Excavation from the surface was then made for a short length between the tunnel and the pond, and back-filled with fine material, which practically shut off the pond water. The water in the pond was drawn down on a Sunday to facilitate operations. Through this very wet area the sewer arch was reinforced.

Surplus Material. — Most of the surplus rock has been crushed and used in concrete; some has been sold and the remainder levelled off within the lines of taking.

SECTION 24 (NEPONSET VALLEY SYSTEM), DEDHAM.

Location. — From a point in Colburn Street, about 40 feet south-east of Maverick Street, extending north-westerly through private land along the northerly bank of Mother Brook to Curve Street.

Diameters of sewers and length of each size: —

4 feet by 4 feet 1 inch,	81 feet.
3 feet 9 inches by 3 feet 10 inches,	2,384 "

Contractors. — Haskin & Murphy of Charlestown, Mass.

Contractors' Superintendent. — Thomas H. Murphy, a member of the above-mentioned firm.

Contractors' Principal Foremen. — Tunnel: Martin McLaughlin, Henry Burke; open cut: John McLauthlin.

*State Assistants.**

Assistant Engineer: Seth Peterson.

Inspectors: George F. Greenlaw, Caleb Kimball, J. E. Savage, John Craib, J. D. Collins.

Transitmen: Principal (in charge of lines and grades) — George S. Miller.

Principal (in charge of records) — George F. Chase.

Assistant — J. T. P. Jones, Eugene Russ, R. D. Greenlaw.

* The above-named State assistants have been employed for a part of the time only on section 24.

Trench and Tunnel.

	4 Feet by 4 Feet 1 Inch Sewer.	3 Feet 9 Inches by 3 Feet 10 Inches Sewer.
Length of trench excavated to bottom of underdrain (feet),	-	1,415.00
Length of tunnel excavated to bottom of underdrain (feet),	81.00	969.00
Average depth of trench excavation to bottom of underdrain (feet),	-	19.00
Greatest depth of trench excavation to bottom of underdrain (feet),	-	25.00
Average width, top of trench (feet),	-	7.30
Average width, bottom of trench (feet),	-	6.50
Average depth from surface of ground to bottom of tunnel excavation (feet),	20.00	20.00
Greatest depth from surface of ground to bottom of tunnel excavation (feet),	23.00	23.00
Average width of tunnel excavation (feet),	6.60	6.60
Volume of trench excavation per linear foot (cubic yards),	-	4.30
Volume of tunnel excavation per linear foot (cubic yards),	1.80	1.80
Approximate cost of trench and tunnel per linear foot, including sheeting left in, excavation and refilling below masonry, back-filling, etc., to completion of work,	\$12 25	\$12 25

Character of Excavation. — The first 1,050 feet of the section were excavated entirely through rock ; this was followed for 1,070 feet by 1 foot loam, then sand, gravel and clay to rock, which ran from bottom to 14 feet above ; and for the remainder of the section, 1 foot loam, then sand and gravel to grade.

Masonry.

Contract prices : —

Brickwork, American cement mortar, per cubic yard,	\$12 50
Brickwork, Portland cement mortar, per cubic yard,	14 00
Concrete, American cement mortar, per cubic yard,	5 50
Concrete, Portland cement mortar, per cubic yard,	6 90

Diameters of underdrain laid and length of each size : —

4-inch,	1,050 feet.
6-inch,	155 “
8-inch,	1,017 “
12-inch,	243 “

Approximate cost of masonry per linear foot of trench and tunnel, including underdrain, tarred paper, etc., to completion of work, \$5.60.

Length of masonry completed (trench)	1,050 feet.
Length of masonry completed (tunnel),	1,415 “

Masonry begun in trench Nov. 4, 1896 ; finished Sept. 26, 1897.
Masonry begun in tunnel Nov. 25, 1896 ; finished Sept. 29, 1897.

Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, to completion of work, \$18.85.

NOTE. — The information regarding Section 24 following this note relates solely to the year ending Sept. 30, 1897. For a description of the work performed prior to this year, see the eighth annual report.

Excavation.

	Opening No. 1.	Opening No. 2.	Opening No. 3.
Character of opening,	Tunnel, . . .	Tunnel, . . .	Open cut.
Number of tunnel headings, . . .	Two,	Two,	- -
Date of starting, .	July 13, 1896, . . .	July 20, 1896, . . .	Aug. 3, 1896.
Points of continuing from last year's work,	Westerly line of Maverick Street and 287 feet westerly therefrom.	At points 300 feet and 600 feet westerly from Maverick Street.	About 1,250 feet westerly from Maverick Street.
Points of ending, .	Beginning of section and 423 feet from beginning.	About 423 feet from beginning of section and 1,050 feet from same.	End of section.
Date of finishing, .	Oct. 30, 1896, . . .	Dec. 23, 1896, . . .	Sept. 18, 1897.
Length,	136 feet,	312 feet,	1,345 feet.
Ordinary progress per week,	40 feet,	30 feet,	30 feet.
Appliances used, .	Elevators and cars, .	Drills run by compressed air.	Travelling derrick and cable-way.
Size of gang ordinarily employed, .	10 men,	13 men,	25 men.

The ground-water was handled as follows: at shaft No. 1 by a 2-inch steam pump; at shaft No. 2 by a pulsometer, which was afterwards replaced by a 4-inch steam pump; and in the open-cut work by a 6-inch centrifugal and a 5-inch steam pump. The estimated greatest rate of pumping in 24 hours was 1,000,000 gallons.

Shut-down.—A shut-down occurred on shaft No. 2 from Feb. 1 to June 3, 1897, on account of bad weather and lack of necessary machinery for working the section.

Foundation.—The bottom excavation has been rock except for about 380 feet at the end of the section, which was in sand and gravel. An invert of concrete was used throughout the section.

Miscellaneous.—The sewer line as it entered Curve Street was moved about $4\frac{1}{2}$ feet, to avoid trees.

SECTION 25 (NEPONSET VALLEY SYSTEM), DEDHAM.

Location.—From a point in Curve Street, about 430 feet east of Washington Street, extending north-westerly through public and private land to a point about 100 feet north-west of the Dedham branch of the New York, New Haven & Hartford Railroad.

Diameter and length of sewer:—

3 feet 9 inches by 3 feet 10 inches, 2,666 feet.

Contractor.—E. W. Everson of Providence, R. I.

Contractor's Superintendent and Foreman.—Geo. W. Upper.

*State Assistants.**

Assistant Engineer: Seth Peterson.

Inspector: Charles Roesbeck.

Transitmen: Principal (in charge of lines and grades) — George S. Miller, S. G. Packard.

Principal (in charge of records) — Geo. F. Chase.

Assistant — J. T. P. Jones, Eugene Russ.

*Trench.*3 Feet 9 Inches by
3 Feet 10 Inches
Sewer.

Length of trench excavated to bottom of underdrain (feet), . . .	2,666.00
Average depth of trench excavation to bottom of underdrain (feet), .	20.50
Greatest depth of trench excavation to bottom of underdrain (feet), .	24.50
Average width, top of trench (feet),	8.00
Average width, bottom of trench (feet),	6.00
Volume of trench excavation per linear foot (cubic yards), . . .	5.30
Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below masonry, back-filling, etc., to com- pletion of work, \$8.10.	

Character of Excavation. — At beginning of section, 8 inches gravel street surfacing, 2½ feet loam, gravel and sand below; 40 feet east of Washington Street, 8 inches surfacing, 2½ feet loam, sand and fine gravel to grade; 200 feet west of Washington Street, 8 inches surfacing, 2½ feet loam, gravel and sand to arch, fine wet sand to grade. From Centre Street for the next 800 feet, 1 foot loam, sand and gravel to grade; 100 feet farther on, 5 feet peat, sand (fine and wet) to grade. This sand runs out in about 150 feet, and for the next 550 feet there are about 6 feet of peat with clayey gravel below. From this point ledge is found in the bottom and rises to a height of 12 feet above water line. The ledge continues at an average height of about 10 feet to within about 60 feet of the end of the section. The material above the ledge is clay, sand and gravel.

Masonry.

Contract prices: —

Brickwork, American cement mortar, per cubic yard,	\$11 50
Brickwork, Portland cement mortar, per cubic yard,	13 50
Concrete, American cement mortar, per cubic yard,	5 00
Concrete, Portland cement mortar, per cubic yard,	6 00

Diameters of underdrain laid and length of each size: —

6-inch,	270 feet.
10-inch,	1,110 "
12-inch,	1,310 "

Approximate cost of masonry per linear foot of trench, including underdrain, tarred paper, etc., to completion of work, \$5.90.

Length of masonry completed (trench), 2,666 feet.

Masonry begun in trench Aug. 26, 1896; finished April 7, 1897.

Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, to completion of work, \$14.25.

NOTE. — The information regarding Section 25 following this note relates solely to the year ending Sept. 30, 1897. For a description of the work performed prior to this year, see the eighth annual report.

* The above-named State assistants have been employed for part of the time only on Section 25.

Excavation.

Character of opening,	Open cut.
Date of starting,	July 27, 1896.
Point of continuing from last year's work,	Curve Street, about 50 feet east of Centre Street.
Point of ending,	At a point about 100 feet north-west of the Dedham branch of the New York, New Haven & Hartford Railroad.
Date of finishing,	March 29, 1897.
Length,	2,016 feet.
Ordinary progress per week,	125 feet.
Appliances used,	Brown Excavator.
Size of gang ordinarily employed,	45 men.

The ground-water was raised by an 8-inch centrifugal pump located about 150 feet west of Centre Street. This pump was also used at a point about 800 feet west of its original location, and later at a point 200 feet east of the railroad. In addition to the foregoing, a 4-inch centrifugal and a No. 5 pulsometer were temporarily used. The estimated maximum rate of pumping in 24 hours was 1,500,000 gallons.

Delay.—Operations were suspended for about two weeks in February, owing to bad weather and high water of the Charles River.

Foundation.—Beginning at a point about 800 feet west of Centre Street, it was found best to excavate to a depth of about 1 foot below the bottom of the masonry, for a distance of about 35 feet, and refill with gravel. For the greater part of the section the bottom of the excavation consisted of sand, gravel, clay and ledge, the concrete being placed directly upon such formations except for a distance of about 48 feet near the end of the section, where a cradle, consisting of ribs 2 by 6 inches, placed 4 feet apart and lined with two thicknesses of 1-inch boards with tar paper between, was used.

Difficulties.—For a length of 200 feet in marsh, where a considerable depth of peat was found overlaying sand, great difficulty was experienced in bracing the trench and keeping it in line.

Under the railroad tracks the sewer arch was reinforced with concrete to a depth of 6 inches.

To tighten the sewer a plaster of Portland cement $\frac{3}{8}$ inch in thickness was applied between the neat and rough work of the arch.

Surplus Material.—A considerable portion of the surplus earth from the excavations was used in the construction of roads to facilitate the transportation of materials to the sewer trench, and in filling low lands in the vicinity.

SECTION 26 (NEPONSET VALLEY SYSTEM), DEDHAM AND WEST ROXBURY.

Location. — From a point in Dedham about 1,500 feet northerly from Mother Brook and about 100 feet north-westerly from the Dedham branch of the New York, New Haven & Hartford Railroad, extending through private and marsh lands, near the Charles River, to Spring Street, West Roxbury.

Diameters and lengths of sewer : —
2 feet 10 inches by 2 feet 11 inches, 1,824 feet.
3 feet 9 inches by 3 feet 10 inches, 2,246 “

Contractors. — National Contracting Company of New York, N. Y.
Contractors' Superintendents. — Mark Wilmarth, Geo. P. Griffith, Jr.
Contractors' Principal Foreman. — William Lindsay.

State Assistants.*

Assistant Engineer: C. Barton Pratt.
Inspectors: Chris Rasmussen, George F. Greenlaw.
Transitmen: Principal — G. E. Stratton.
Assistant — M. F. Sanborn, Walter Cleary, William Hobbs.

Trench.

	2 Feet 10 Inches by 2 Feet 11 Inches Sewer.	3 Feet 9 Inches by 3 Feet 10 Inches Sewer.
Length of trench excavated to bottom of underdrain (feet), . . .	566.00	520.00
Average depth of trench excavation to bottom of underdrain (feet),	15.00	17.30
Greatest depth of trench excavation to bottom of underdrain (feet),	15.00	18.00
Average width, top of trench (feet),	6.80	8.00
Average width, bottom of trench (feet),	5.50	6.70
Volume of trench excavation per linear foot (cubic yards), . . .	3.40	4.70
Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below masonry, back-filling, etc., to date (Sept. 30, 1897),	\$5 24	\$7 57

Character of Excavation. — From the beginning of the section near the Dedham branch of the New York, New Haven & Hartford Railroad, and for a distance of 260 feet, the formation consisted of 5 feet peat, then sand and clay to grade. About 1,986 feet from the beginning of the section, all peat for a distance of 219 feet. About 2,205 feet from the beginning of the section, peat from 16 to 11 feet deep, then fine sand and clay to grade. This last formation extended for a distance of 345 feet. About 2,550 feet from the beginning of the section, peat from 11 to 7 feet in depth, then 3 feet fine sand, gravel and clay, then gravel to grade, the formation extending for a distance of 100 feet. About 2,650 feet from the beginning of section, and near the southerly entrance to Caledonian Grove, peat from 3 to 7 feet in depth, on top of gravel and boulders, the formation extending for 162 feet.

* The above-named State assistants, except Mr. Chris Rasmussen, have been employed for part of the time only on Section 26.

Masonry.

Contract prices : —

Brickwork, American cement mortar, per cubic yard,	. . . .	\$11 45
Brickwork, Portland cement mortar, per cubic yard,	. . . .	13 45
Concrete, American cement mortar, per cubic yard,	. . . .	4 90
Concrete, Portland cement mortar, per cubic yard,	. . . .	6 50

Diameters of underdrain laid and length of each size : —

6-inch by 8-inch box drain,	. . . . .	28 feet.
8-inch,	. . . . .	38 “
10-inch,	. . . . .	688 “
12-inch,	. . . . .	126½ “

Approximate cost of masonry per linear foot of trench, including underdrain, tarred paper, etc., to Sept. 30, 1897 : —

2 feet 10 inches by 2 feet 11 inches sewer,	. . . . .	\$4 22
3 feet 9 inches by 3 feet 10 inches sewer,	. . . . .	5 67

Length of masonry completed : —

2 feet 10 inches by 2 feet 11 inches sewer,	. . . . .	544 feet.
3 feet 9 inches by 3 feet 10 inches sewer,	. . . . .	363 “

Masonry was begun in trench July 19, 1897, and is now, in progress.

Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, to Sept. 30, 1897, \$12.05.

Excavation.

	Opening No. 1.	Opening No. 2.
Character of opening,	Open cut,	Open cut.
Date of starting,	June 24, 1897,	Aug. 4, 1897.
Point of beginning,	About 2,800 feet from beginning of section in marsh and near road leading to the south end of Caledonian Grove, working down grade of sewer.	At the lower end of section, about 100 feet north-westerly from the Dedham branch of the New York, New Haven & Hartford Railroad, and about 1,500 feet northerly from Mother Brook, working up grade of sewer.
Point where work was in progress Sept. 30, 1897,	About 2,000 feet from the beginning of section and about 800 feet south of the southerly entrance to Caledonian Grove.	About 270 feet from beginning of section.
Length,	816 feet,	270 feet.
Ordinary progress per week,	72 feet,	48 feet.
Appliances used,	Carson Trench Machine,	Carson Trench Machine.
Size of gang ordinarily employed,	60 men,	60 men.

The ground-water was raised by a 6-inch centrifugal pump located at a well about 45 feet from the beginning of the section, near the Dedham branch of the New York, New Haven & Hartford Railroad, the estimated greatest rate of pumping in 24 hours being 280,000 gallons ; and by a 6-inch centrifugal pump located

at a well about 2,700 feet from the beginning of the section and 100 feet south of the southerly entrance to Caledonian Grove; the estimated rate of pumping in 24 hours being 350,000 gallons.

Foundation. — It was necessary to excavate below the bottom of the masonry to a depth of about 15 inches and refill with different material for all of the section completed to date, with the exception of about 157 feet of pile section and about 172 feet of cradle section near the southerly entrance to Caledonian Grove. The material removed below grade has consisted of peat, fine sand and clay, and the refilling of bank and screened gravel.

A pile foundation was driven for a length of approximately 157 feet, beginning at a point about 600 feet south of the southerly road to Caledonian Grove, in marsh land adjacent to the Charles River, the piles varying in length from 15 to 44 feet. A peaty formation existed where this pile foundation was driven.

Where cradling was used near the southerly entrance to Caledonian Grove, the formation at the bottom of the trench consisted of sand and gravel. Inside the cradle a full 8-inch section was built.

Where piling or cradling was not used the trench was excavated about 2 feet below sewer grade and refilled. On this a concrete invert was built, giving about 6 inches of concrete in the bottom and 6 to 8 inches on the sides of the brick masonry. A 4-inch Portland brick invert was laid in the concrete; an 8-inch arch of American brick masonry was used, with $\frac{3}{8}$ inch of Portland cement plaster.

SECTION 27 (NEPONSET VALLEY SYSTEM), WEST ROXBURY.

Location. — From a point in Spring Street, West Roxbury, near the easterly bank of the Charles River, extending north-westerly through private and marsh lands near the Charles River to Gardner Street, and in Gardner Street for about 500 feet.

Diameter and length of sewer:—

2 feet 10 inches by 2 feet 11 inches, 3,457.7 feet.

Contractor. — National Contracting Company of New York, N. Y.

Contractor's Superintendents. — Mark Wilmarth, Geo. P. Griffith, Jr.

Contractor's Principal Foreman. — William Lindsay.

*State Assistants.**

Assistant Engineer: C. Barton Pratt.

Inspectors: Caleb Kimball, John Collins, John E. Savage.

Transitmen: Principal — G. E. Stratton.

Assistant — M. F. Sanborn, Walter Cleary, William Hobbs.

* The above-named State assistants, except Mr. Caleb Kimball, have been employed for a part of the time only on Section 27.

Trench.

2 Feet 10 Inches by
2 Feet 11 Inches
Sewer.

Length of trench excavated to bottom of underdrain (feet),	1,847.00
Average depth of trench excavation to bottom of underdrain (feet),	12.00
Greatest depth of trench excavation to bottom of underdrain (feet),	13.00
Average width, top of trench (feet),	7.10
Average width, bottom of trench (feet),	6.10
Volume of trench excavation per linear foot (cubic yards),	3 00
Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below masonry, back-filling, etc., to Sept. 30, 1897, \$5.22.	

Character of Excavation. — From a point about 150 feet from Spring Street in Opening No. 2, the excavation was in from 2½ to 12 feet of peat, with coarse sand to grade for a distance of 452 feet. From the beginning of Opening No. 1, about 1,100 feet from Spring Street, the excavation was in from 2 to 5 feet of peat, 2 to 5 feet sand and gravel, then fine sand and clay to grade, this formation extending for a distance of about 435 feet. Then the excavation was through 8 feet of peat, followed by fine sand and gravel to grade for 100 feet. Then for a distance of 370 feet, the entire formation through which the excavation ran consisted of peat. Then for a distance of 490 feet, 8 feet peat, then coarse sand to grade.

Masonry.

Contract prices : —

Brickwork, American cement mortar, per cubic yard,	\$11 45
Brickwork, Portland cement mortar, per cubic yard,	13 45
Concrete, American cement mortar, per cubic yard,	4 90
Concrete, Portland cement mortar, per cubic yard,	6 50

Diameters of underdrain laid and length of each size : —

8-inch,	182 feet.
8-inch by 10-inch wood,	277 “
10-inch,	1,336 “
12-inch,	32 “

Approximate cost of masonry per linear foot of trench, including underdrain, tarred paper, etc., to Sept. 30, 1897, \$4.61.

Length of masonry completed, 1,744 feet.

Masonry was begun in trench June 29, 1897, and is now (Sept. 30, 1897) in progress.

Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, to Sept. 30, 1897, \$10.27.

Excavation.

	Opening No. 1.	Opening No. 2.
Character of opening,	Open cut,	Open cut.
Date of starting,	June 10, 1897,	Aug. 28, 1897.
Point of beginning,	Near Charles River and about 1,100 feet north-east from Spring Street in Parental School grounds.	Near Charles River and about 50 feet north-east from Spring Street in Parental School grounds.
Point where work was in progress Sept. 30, 1897,	About 2,500 feet from Spring Street, near the easterly bank, Charles River, in private land.	About 500 feet from Spring Street, in private land near easterly bank, Charles River, in Parental School grounds.
Length,	1,379 feet,	524 feet.
Ordinary progress per week,	For the first 700 feet, about 48 feet; for the next 600 feet, about 144 feet.	144 feet.
Appliances used,	Carson Trench Machine,	Carson Trench Machine.
Size of gang ordinarily employed,	60 men,	60 men.

The ground-water on this section has been disposed of as follows :—

A 6-inch centrifugal pump was used at a well about 100 feet north-westerly from Spring Street, in the Parental School grounds ; estimated maximum rate of pumping in 24 hours, 300,000 gallons.

A 4-inch pulsometer was used at a well located about 1,200 feet north-westerly from Spring Street, in the Parental School grounds; estimated maximum rate of pumping in 24 hours, 100,000 gallons.

An 8-inch centrifugal pump was used at a well about 1,600 feet from Spring Street and about 125 feet from the easterly bank of the Charles River; estimated maximum rate of pumping in 24 hours, 500,000 gallons.

Foundation.—It was found necessary to excavate below the bottom of the masonry and refill with screened gravel, to a depth of about 2 feet, for 155 feet up grade from a point 225 feet from the beginning of the section; for 300 feet up grade from a point 1,940 feet from the beginning of the section; and for a distance of 500 feet up grade from a point 1,100 feet from the beginning of the section. The bottom excavation was in fine sand and clay.

A pile foundation was built for a distance of 258 feet from a point in private land, near the Charles River, and about 1,600 feet northerly from Spring Street. The piles varied in length from 10 to 33 feet. The formation where piling was used consisted principally of peat.

Difficulties. — The trench was flooded at a point about 1,660 feet from Spring Street, where the trench approached near to the Charles River. Water having found its way from the river to the trench through holes in the peat, 6 or 7 feet below the surface of the marsh, 3-inch sheet piling was driven between the trench and the river for a short distance at this point.

On Opening No. 1 the vertical diameter of the sewer was increased 4 inches for a distance of 1,141 feet.

Surplus Material.—Considerable of the surplus earth has been used to fill low areas in a portion of the Parental School grounds.

SECTION 28 (NEPONSET VALLEY SYSTEM), WEST ROXBURY.

Location. — From a point in West Roxbury, about 5 feet north-east of Gardner Street and about 150 feet north-west of the railroad siding leading to the ice-houses of the Highland Ice Company, extending north-easterly through private lands to Baker Street.

Diameters of sewers and length of each size :—

[illegible]

Contractors.—Felton and Holbrook, Cabot & Daly of Boston, Mass.

The work was superintended by members of the firm.

State Assistants.*

Assistant Engineer : C. Barton Pratt.
Inspectors : Cornelius J. Regan, H. M. Woodward, John D. Collins.
Transitmen : Principal — J. L. Brown.
Assistant — Walter Cleary, A. B. Cleaveland, William Hobbs.

Trench and Tunnel.

	2 Feet 8 Inches Sewer.	2 Feet 2 Inches Sewer.
Length of trench excavated to bottom of underdrain (feet), . . .	3,346.58	1,220.44
Average depth of trench excavation to bottom of underdrain (feet),	10.00	6.70
Greatest depth of trench excavation to bottom of underdrain (feet),	14.50	11.00
Average width, top of trench (feet),	5.30	4.40
Average width, bottom of trench (feet),	5.10	4.40
Volume of trench excavation per linear foot (cubic yards), . .	1.90	1.00
Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below masonry, back-filling, etc., to Sept. 30, 1897,	\$2 92	\$1 76

Character of Excavation. — From the beginning of the section at Gardner Street and for a distance of about 1,100 feet the excavation was through about 1 foot loam, 4 feet sand and gravel, then fine sand and some clay to grade. For the next 700 feet, peat averaging 7 feet in depth, then sand to grade. For 300 feet from this point, 4 feet peat, 2 feet white sand, then sand and gravel to grade. For the next 550 feet, about 10 feet peat, then fine sand and clay to grade. For 700 feet, about 7 feet peat, then clay, sand and gravel to grade. For 850 feet, from 2 to 4 feet black peat, then clay, sand and gravel to grade. Then for the next 367 feet to the end of the section at Baker Street, 1½ feet loam and peat, then coarse gravel, sand and clay to grade.

Masonry.

Contract prices : —

Brickwork, American cement mortar, per cubic yard,	\$12 75
Brickwork, Portland cement mortar, per cubic yard,	13 50
Concrete, American cement mortar, per cubic yard,	5 75
Concrete, Portland cement mortar, per cubic yard,	7 75

Diameters of underdrain laid and length of each size : —

6-inch,	1,643 feet.
8-inch,	2,199 “
10-inch,	745 “

Approximate cost of masonry per linear foot of trench, including underdrain, tarred paper, etc., to Sept. 30, 1897 : —

2 feet 8 inches sewer,	\$4 22
2 feet 2 inches sewer,	2 11

Length of masonry completed : —

2 feet 8 inches sewer,	3,346.58 feet.
2 feet 2 inches sewer,	1,220.44 “

Masonry begun in trench June 29, 1897 ; finished Sept. 28, 1897.

Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, to completion of work, \$6.46.

* The above-named State assistants, with the exception of H. M. Woodward, have been employed for part of the time only on Section 28.

Excavation.

	Opening No. 1.	Opening No. 2.	Opening No. 3.	Opening No. 4.
Character of opening,	Open cut,	Open cut,	Open cut,	Open cut.
Date of starting,	June 9, 1897,	June 16, 1897,	June 22, 1897,	June 25, 1897.
Point of beginning,	About 1,700 feet from beginning of section and near the site of the old Brookline Pumping Station, working up stream.	About 3,300 feet from beginning of section and about 1,600 feet north of the old Brookline Pumping Station in marsh lands on Lutheran Church estate.	About 1,700 feet from the beginning of section and near the site of the old Brookline Pumping Station, working down stream.	At lower end of section near Gardner Street.
Point of ending,	About 3,300 feet from beginning of section and about 1,600 feet north of the old Brookline Pumping Station in marsh lands on Lutheran Church estate.	At Baker Street near Martin Luther Home.	About 1,300 feet from beginning of section at Gardner Street.	About 1,300 feet from beginning of the section at Gardner Street.
Date of finishing,	Aug. 16, 1897,	Sept. 18, 1897,	Aug. 7, 1897,	Sept. 24, 1897.
Length,	1,600 feet,	1,267 feet,	400 feet,	1,300 feet.
Ordinary progress per week,	180 feet,	100 feet,	100 feet,	96 feet.
Appliances used,	Hand labor,	Hand labor,	Hand labor,	Hand labor.
Size of gang ordinarily employed,	60 men,	35 men,	35 men,	35 men.

A number of wells were sunk on this section for handling the ground-water, located as follows: 25 feet, 700 feet, 1,030 feet, 1,320 feet, 1,735 feet, 3,317 feet, 4,000 feet and 4,300 feet from the beginning of the section. Six-inch centrifugal pumps were generally used. A 4-inch pulsometer was used at the well 3,317 feet from the beginning of the section, and at the one in private land 4,300 feet from the beginning of the section. In the last-named well hand pumps were also used.

Foundation. — For a distance of 3,100 feet from the beginning of the section it was necessary to excavate to a depth of 14 inches below the bottom of the masonry and refill with different material. For 2,250 feet the formation removed consisted of fine sand mixed with some clay and gravel; for 300 feet, peat; and for 250 feet, fine sand.

Miscellaneous. — From Gardner Street for a distance of 1,735 feet easterly the sewer line was moved about 6 feet from its original location, in order to clear as much as possible the pipes of the Brookline Water Works, which run parallel with the sewer.

Surplus Material. — The surplus material from the excavation has been used for banking man-holes; the remainder has been spread over the trench within the lines of taking.

SECTION 29 (NEPONSET VALLEY SYSTEM), WEST ROXBURY.

Location. — From a point in Baker Street, West Roxbury, about 670 feet north-west of Weld Street, extending through public and private lands to a point in Weld Street about 300 feet north-west of Dwinell Street.

Diameters of brick sewers and length of each size: —

2 feet 2 inches,	. . . . .	453.80 feet.
1 foot 8 inches,	. . . . .	1,947.71 “

Diameters of pipe sewers and length of each size: —

1 foot 3 inches,	. . . . .	2,156.37 feet.
1 foot,	. . . . .	158.24 “

Contractor. — Dennis F. O'Connell of Dorchester, Mass. Mr. O'Connell has acted as his own superintendent.

Contractor's Principal Foremen. — Michael Stapleton, Oscar Roesbeck, William Fairbanks.

*State Assistants.**

Assistant Engineer: C. Barton Pratt.

Inspectors: John Collins, Geo. A. Chase, J. E. Savage, Charles Roesbeck.

Transitmen: Principal — J. L. Brown, George F. Chase.

Assistant — F. W. Crispin, William Hobbs.

* The above-named State assistants, except Mr. George A. Chase and Mr. F. W. Crispin, have been employed for a part of the time only on Section 29.

Trench.

	2 Feet 2 Inches Brick Sewer.	1 Foot 8 Inches Brick Sewer.	1 Foot 3 Inches Pipe Sewer.	1 Foot Pipe Sewer.
Length of trench excavated to bottom of under- drain (feet),	453.80	1,947.71	2,156.37	158.24
Average depth of trench excavation to bottom of underdrain (feet),	13.00	10.00	10.50	16.50
Greatest depth of trench excavation to bottom of underdrain (feet),	15.00	17.00	18.50	17.00
Average width, top of trench (feet),	4.00	3.80	3.50	3.50
Average width, bottom of trench (feet),	4.00	3.80	3.50	3.50
Volume of trench excavation per linear foot (cubic yards),	1.90	1.40	1.35	2.10
Approximate cost of trench per linear foot, in- cluding sheeting left in, excavation and refilling below masonry, back-filling, etc., to completion of work,	\$4 63	\$2 09	\$2 34	\$3 95

Character of Excavation. — From the beginning of the section and for a distance of 200 feet there was a strip of ledge from 1 to 14 feet in depth and covered with loam, sand and gravel; the next 250 feet, hard sand and gravel; next 950 feet, 1 to 2 feet loam, then sand and clay to grade; then for 1,100 feet, 1 foot loam, fine sand, sand and gravel, with some places a little clay, to grade; for the next 500 feet, street surfacing, then fine sand to grade; then for 1,000 feet, 1 to 3 feet peat, then fine sand to grade; next 550 feet, 1 to 2 feet loam, clay and sand to grade; for 166 feet on Weld Street, street surfacing, then fine sand and gravel to grade, with a considerable number of boulders.

Masonry.

Contract prices : —

Brickwork, American cement mortar, per cubic yard,	\$13 00
Brickwork, Portland cement mortar, per cubic yard,	14 50
Concrete, American cement mortar, per cubic yard,	5 00
Concrete, Portland cement mortar, per cubic yard,	6 25

Diameters of underdrain laid and length of each size : —

6-inch,	617 feet.
8-inch,	3,762 "

Approximate cost of masonry per linear foot of trench, including underdrain, tarred paper, etc., to completion of work : —

2 feet 2 inches brick sewer,	\$2 17
1 foot 8 inches brick sewer,	1 74
1 foot 3 inches pipe sewer,	52
1 foot pipe sewer,	1 51

Length of masonry completed, 2,401.51 feet.

Masonry begun in trench July 2, 1897; finished Sept. 30, 1897.

Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, to completion of work, \$3.84.

Excavation.

	Opening No. 1.	Opening No. 2.	Opening No. 3.	Opening No. 4.
Character of opening,	Open cut,	Open cut,	Open cut,	Open cut.
Date of starting,	June 22, 1897,	June 28, 1897,	July 1, 1897,	Aug. 9, 1897.
Point of beginning,	About 450 feet from Baker Street in private lands, St. Joseph's Cemetery.	About 450 feet from Baker Street in St. Joseph's Cemetery.	Near corner of Weld and La Grange streets.	In private land about 1,000 feet from La Grange Street.
Point of ending,	Baker Street near Martin Luther Home.	In La Grange Street near corner of Weld Street.	In private land about 1,000 feet from La Grange Street.	In Weld Street about 300 feet north-westerly from Dwinell Street.
Date of finishing,	Sept. 4, 1897,	Sept. 25, 1897,	Aug. 30, 1897,	Sept. 16, 1897.
Length,	450 feet,	1,968 feet,	1,307 feet,	992 feet.
Ordinary progress per week,	50 feet,	196 feet,	200 feet,	200 feet.
Appliances used,	Hand labor,	Hand labor,	Hand labor,	Hand labor.
Size of gang ordinarily employed,	24 men,	28 men,	28 men,	30 men.

The ground-water was raised by means of pumps located as follows: At well about 450 feet from the beginning of the section, No. 6 pulsometer; estimated greatest rate of pumping in 24 hours, 125,000 gallons. At well in La Grange Street, about 1,356 feet from the beginning of the section, 3-inch horizontal pump; estimated greatest rate of pumping in 24 hours, 80,000 gallons. At well in Weld Street, corner of La Grange Street, hand pump. At well on Newfield Street, about 300 feet from Weld Street, No. 6 pulsometer; estimated greatest rate of pumping in 24 hours, 100,000 gallons. Three other wells were sunk in private lands, 2,973 feet, 3,798 feet and 4,510 feet respectively from the beginning of the section; at each of these wells hand pumps were introduced.

For the greater portion of the section it was necessary to excavate below the bottom of the masonry to a depth of from 1 foot to 1½ feet and refill with screened gravel, the material removed consisting of fine sand occasionally mixed with clay.

The bottom of the trench at points other than as stated above has consisted of ledge, sand and gravel; where such formation has existed either cradle or a concrete foundation has been used.

Miscellaneous. — About 500 feet from the beginning of the section, where the sewer passes through private land, intended at a later date to be filled, the arch comes within about 3 feet of the surface.

Surplus Material. — The surplus material has been used in filling low areas adjacent to the line of the sewer.

NEPONSET RIVER CROSSING, MILTON LOWER MILLS.

Location. — Starting from a man-hole on the Dorchester Intercepting Sewer near the junction of Baker's Court and Washington Street, Dorchester, extending about 60 feet to a man-hole near the abutment of the bridge over the Neponset River; thence under, and attached to, the bridge to a man-hole near the bridge abutment on the Milton side; a total distance of 201 feet.

Day Work.

Assistant Engineer: Seth Peterson.*

Character of Structure. — The structure consists of 57 feet of 8-inch Akron pipe and 144 feet of 8-inch heavy cast-iron water pipe. Two man-holes were constructed, one on either side of the river, and between these was laid the cast-iron pipe suspended by wrought-iron hangers to the floor-girders of the bridge.

* Employed for a small part of the time only on this work.

Progress. — The work was commenced about the first of July and was completed about the end of that month.

	<i>Cost.</i>
Labor and teaming,	\$283 25
Cement, pipe, brick, lumber, etc.,	216 11
Miscellaneous expenditures,	20 58
	<hr/> \$519 94

NEPONSET RIVER CROSSING, CENTRAL AVENUE.

Location. — Starting from a man-hole on the Metropolitan Sewer, Section 12, at Central Avenue, extending southerly to the Neponset River; thence across the river on the girders of the bridge across the Neponset River and under the tracks of the Old Colony system of the New York, New Haven & Hartford Railroad to a point in Central Avenue, Milton, about 10 feet southerly from the railroad; a total distance of 294 feet.

Day Work.

Assistant Engineer: Seth Peterson.*

Character of Structure. — The structure consists of about 90 feet of 15-inch Akron pipe, laid from the man-hole on the Metropolitan Sewer to a man-hole just outside the abutment of the Central Avenue bridge. . About 204 feet of 16-inch heavy cast-iron pipe, laid on angle irons supported on the bottom chords of the bridge trusses, connect the latter man-hole with a man-hole on the southerly side of the bridge, at a point about 10 feet south of the tracks of the Old Colony system of the New York, New Haven & Hartford Railroad.

Progress. — The work was commenced in the latter part of July and was completed about Aug. 25, 1897.

	<i>Cost.</i>
Labor and teaming,	\$581 52
Cement, pipe, brick, lumber, etc.,	737 35
Miscellaneous expenditures,	84 55
	<hr/> \$1,403 42

NEPONSET RIVER CROSSING, MATTAPAN SQUARE.

Location. — Beginning at the point of connection with the Neponset Valley Intersecting Sewer; thence passing the Mattapan station of the Old Colony system of the New York, New Haven & Hartford Railroad; thence across and under the river about 30 feet down stream from the bridge between Boston and Milton; thence extending into the town of Milton for a distance of about 30 feet; the total distance being about 198 feet.

Day Work.

Assistant Engineer: Seth Peterson.*

* Employed for a small part of the time only on this work.

Character of Structure.—The structure consists of 96 feet under the river of extra-heavy, 20-inch cast-iron pipe, surrounded with Portland cement concrete 1 foot in thickness; and the remainder of 20-inch Akron pipe, surrounded with American cement concrete 6 inches in thickness. Heavily reinforced cast-iron pipe was used under the river, as a new bridge is soon to be built, the abutments of which may extend over the sewer.

The underdrain laid consists of 60 feet of 4-inch, 30 feet of 6-inch and the balance of 8-inch pipe. Two man-holes were constructed, one near the end of the iron pipe on the Milton side and one at the junction with the main interceptor.

Method of Construction and Miscellaneous.—A well was sunk near the bank of the river on the Milton side and a 6-inch centrifugal pump located there. In crossing the river a coffer-dam was used, the outer sheeting of which rested on the bed of the stream, the inner sheeting being driven as the excavation progressed.

As the bottom of the river on the Milton side consisted of boulders and gravel resting on a bed of ledge, the sheeting could not be driven in advance of the digging. This rendered it necessary to set the outer sheeting of the coffer-dam around a frame of timbers and upon the bed of the stream. To prevent any lateral sliding which might be caused by the force of the river current, iron piles were driven where possible, to which the timbers were anchored.

Width of coffer-dam over all,	10 feet.
Width of trench,	4 “
Width between inner and outer sheeting,	3 “

The space between the inner and outer sheeting of the coffer-dam was filled with sand and clay from one of the shore trenches.

While the sewer operations were in progress, quite a strong current existed, the depth of the river at this point being about 5 feet. It was not deemed advisable to occupy more than one-third of the cross-section of the stream at one time.

The coarse bottom of the river yielded water very freely. A 4-inch pulsometer was brought into service, but it was found to be insufficient to control the leakage.

Blasting was necessary in two of the coffer-dam sections where ledge was encountered.

The trench was 17 feet in depth on the Mattapan side of the river, the bottom 5 feet being in rock for a distance of about 60 feet. The excavation in the river extended about 5 feet below the river bed.

On both sides of the river are retaining walls through which the sewer structure had to be built. The wall on the Boston side,

which had been topped up with timber, was in a dilapidated condition. As left, it is in a much better condition than when the sewer operations were begun.

Progress. — The work was begun June 7, 1897; finished Sept. 7, 1897.

	<i>Cost.</i>
Labor and teaming,	\$2,686 67
Coal for pumping,	69 44
Iron pipe,	183 84
Akron pipe,	88 83
Lumber,	313 29
Brick,	47 50
Cement,	216 45
Miscellaneous items, including gravel, tools, oil, man-hole frames and covers, nails, blacksmith work, etc,	207 48
	<hr/> \$3,813 50

CEMENT TESTING.

Approximately 20,000 barrels of cement have been used during the year, in the proportions of about 7,000 barrels of Portland cement to about 13,000 barrels of American cement.

The cement, which has been of the best English and American brands, has been carefully tested for fineness, tensile strength, specific gravity, checking, cracking, etc., about 5,000 tests having been made.

TABLE OF PROGRESS.

The following table recapitulates to some extent the detailed information given in the foregoing pages and in reports of preceding years. The Charles River Valley sections are designated by letters and those of the North Metropolitan and Neponset Valley areas by numbers.

Where work on the same section has continued through two or more years some statistics and other statements contained in former reports have been repeated for convenience of reference. This is desirable, among other reasons, on account of the great scarcity of some of the earlier reports.

The foregoing detailed reports of sections are in general condensed from those of the various assistant engineers directly connected with the work.

Table showing Locations, Lengths, Depths and Sizes of Sewers, Name of Contractor, Date of Completion of Each Section named in Contract, and Other Data in relation to Metropolitan Sewer Work, from May, 1890, to Sept. 30, 1897.

Section.	LOCALITY.	NAME OF CONTRACTOR.	Total Length of Section. Feet.	SIZE OF SEWER.		Average Depth of Trench, Bottom of Underdrain or Deeper Excavation. Feet.	Length of Sewer completed Sept. 30, 1897. Feet.	Date of Completion named in Contract.
O	Boston,	Built by city of Boston,	1,897	6" 6", . . . . .	. . . . .	23	1,897	May, 1890
A	Boston,	H. C. Eyre,	3,701	5' 6", . . . . .	. . . . .	20.3	3,701	Aug. 31, 1891
B	Boston and Brookline,	H. C. Eyre,	2,962	5' 6", . . . . .	. . . . .	18.5	2,962	Feb. 28, 1891
C	Brighton,	National Construction Co.,	5,787	4' 10", . . . . .	. . . . .	16.4	5,787	Aug. 31, 1891
D	Brighton,	National Construction Co.,	5,300	4' 10"×5' 3", . . . . .	. . . . .	17.2	5,300	July 31, 1891
E	Brighton,	Jones & Meehan,	8,027	4' 6"×5' 1", . . . . .	. . . . .	14.7	8,027	Nov. 30, 1891
F	Newton and Watertown,	Jones & Meehan,	7,675	4' 2"×4' 9", 3' 11"×4' 5", . . . . .	. . . . .	10.4	7,675	Nov. 30, 1891
G	Newton,	Jones & Meehan,	2,800	3' 11"×4' 5", 3' 6"×4', . . . . .	. . . . .	19.1	2,800	Nov. 30, 1891
H	Newton,	Metropolitan Construction Co.,	4,497	3' 6"×4', . . . . .	. . . . .	13.7	4,497	Nov. 30, 1891
1	Deer Island,	Day work,	1,931	6' 3", . . . . .	. . . . .	14	1,931	-
2	Deer Island,	National Construction Co.,	2,120	{ Outfall sewer, 6'×6' to 6'×10', Main sewer, 9', }		17 28	2,120	Feb. 29, 1892
3	Deer Island,	R. A. Malone & Co.,	2,641	9', . . . . .	. . . . .	26	2,641	April 30, 1891
3½	Deer Island and Winthrop,	Day work,	430	{ Main sewers, 9', 6' 4", Sand-catcher, 16'×16', Siphon, 6' 2", }		21 23 13	138 28 264	-
4	Winthrop,	Metropolitan Construction Co.,	5,710	9', . . . . .	. . . . .	22	5,710	June 30, 1891

Table showing Locations, Lengths, Depths and Sizes of Sewers, etc. — Continued.

Section.	LOCALITY.	NAME OF CONTRACTOR.	Total Length of Section. Feet.	SIZE OF SEWER.	Average Depth of Trench, Bottom of Underdrain or Deeper Excavation. Feet.	Length of Sewer completed Sept. 30, 1897. Feet.	Date of Completion named in Contract.
5	Winthrop,	Metropolitan Construction Co., .	4,600	9',	16	4,600	July 31, 1891
6	Winthrop,	Metropolitan Construction Co., .	4,113	9',	18	4,113	May 31, 1891
7	Winthrop and East Boston,	Trumbull & Ryan,	848	{ Main sewer, 8' 6"×9' 2", Sand-catcher, 16'×16' 5", and siphon ap- proaches, Siphon (3 parallel lines), 5',	{ 6.5 11.4 13.6 }	848	June 1, 1893
8	Breed's Island,	Charles Linehan,	4,126	9',	16.4	4,126	Aug. 31, 1891
9	East Boston and Chelsea,	Charles Linehan,	3,383	9',	15.8	3,383	May 31, 1891
10	East Boston and Chelsea,	Day work,	709	{ Siphon, 5' 8", Sand-catcher, 15' 5"×16' 1",	{ 53* 23† }	709	-
11	Chelsea,	Charles Linehan,	3,034	2' 1"×2' 10",	17.0	3,034	Sept. 30, 1894
12	Chelsea,	Orin P. Roberts,	3,034	8' 4"×9',	27.0	3,034	April 30, 1893
14	Chelsea,	Metropolitan Construction Co., .	3,445	8' 10", 8' 4"×9', 8' 2"×8' 10",	{ 28.60* 37.0† }	3,445	Dec. 30, 1893
15	Chelsea,	Christy McBride,	1,754	8' 2"×8' 10",	23.2	1,754	May 31, 1892
16	Everett,	R. A. Malone & Son,	4,431	{ 8' 2"×8' 10", 5' 10"×6' 4",	{ 21.1 20.7 }	4,431	Nov. 30, 1892
17	Everett,	Christy McBride,	3,528	5' 10"×6' 4", 4' 8"×5' 1",	21.4	3,528	Sept. 30, 1892
17½	Everett,	Metropolitan Construction Co., .	1,627	4' 8"×5' 1",	17.0	1,627	Sept. 30, 1892

19	Everett and Medford,	. . . . .	Day work,	. . . . .	496	{ Sand catcher, 10 X 11' 3", 4' 8" X 5' 1", 3' 6", 3' 6", 4' 8" X 6' 2", 3' 6", . . . . . }	. . . . .	. . . . .	. . . . .	{ 13.0 267 229 }	-
20	Medford,	. . . . .	John Sheehan,	. . . . .	9,170	{ Main line, 4' 8" X 5' 1", 4' 5" X 4' 8", Edgeworth branch, 2', . . . . . }	. . . . .	. . . . .	. . . . .	{ 18.5 9,170 13.3 }	April 30, 1893
21	Medford,	. . . . .	National Construction Co.,	. . . . .	8,030	4' 5" X 4' 8", 4' 3" X 4' 6", . . . . .	. . . . .	. . . . .	. . . . .	14.0	Feb. 28, 1893
21	Medford (Gravelly Brook culvert),	{	Sub-contractors: Wm. H. Lenox & Co., A. W. Bryne, }	{	54	4' 5" X 4' 8", . . . . .	. . . . .	. . . . .	. . . . .	12.8	54
21	Medford (Winthrop Street culvert),	. . . . .	Day work,	. . . . .	181	4' 3" X 4' 6", . . . . .	. . . . .	. . . . .	. . . . .	6.5	181
22	West Medford,	. . . . .	Andrew W. Bryne,	. . . . .	6,033	3' 4" X 3' 6", . . . . .	. . . . .	. . . . .	. . . . .	{ 23.0* 5,347 28.0† }	June 30, 1893
23	Everett,	. . . . .	R. A. Malone & Sons,	. . . . .	2,268	6' X 6' 8", . . . . .	. . . . .	. . . . .	. . . . .	25.3	June 30, 1892
24	Everett and Charlestown,	. . . . .	Metropolitan Construction Co.,	. . . . .	2,332	6' X 6' 8", . . . . .	. . . . .	. . . . .	. . . . .	25.0	Sept. 30, 1892
25	Charlestown,	. . . . .	Day work,	. . . . .	1,540	{ Main sewer, 6' X 6' 8", 6' X 7' 1", Siphon, 5', . . . . . }	. . . . .	. . . . .	. . . . .	{ 23.1* 1,540 44.0† }	-
25½	Charlestown,	. . . . .	Day work,	. . . . .	585	6' 7" X 7' 5", 6' 5" X 7' 2", . . . . .	. . . . .	. . . . .	. . . . .	27.3	585
25½	Arlington Avenue connection,	. . . . .	Day work,	. . . . .	61	3' 4" X 4' 1", . . . . .	. . . . .	. . . . .	. . . . .	-	61
26	Charlestown and Somerville,	. . . . .	Harry P. Nawn,	. . . . .	3,750	{ 6' 5" X 7' 2", 5' 9" X 6' 6", . . . . . }	. . . . .	. . . . .	. . . . .	{ 34.3† 3,750 23.5* 28.8† }	Nov. 30, 1893
26½ 27†	Somerville,	. . . . .	Day work,	. . . . .	950	5' 9" X 6' 6", . . . . .	. . . . .	. . . . .	. . . . .	35.0†	950
27	Somerville and Cambridge,	. . . . .	{ McGovern & Kitch, Metropolitan Construction Co., Day work, }	{	4,326	{ 5' 9" X 6' 6", 5' 2" X 5' 9", . . . . . }	. . . . .	. . . . .	. . . . .	{ 24.4* 4,326 22.9* 25.5† }	Aug. 31, 1893
28	Cambridge,	. . . . .	John L. Reardon & Co.,	. . . . .	6,503	4' X 4' 6", . . . . .	. . . . .	. . . . .	. . . . .	{ 19.2* *6,424 23.0† †79 }	April 30, 1894

* Trench.

† Tunnel.

‡ Part of.

Table showing Locations, Lengths, Depths and Sizes of Sewers, etc. — Continued.

Section.	LOCALITY.	NAME OF CONTRACTOR.	Total Length of Section, Feet.	SIZE OF SEWER.	Depth of Trench, Bottom of Underdrain or Deeper Excavation, Feet.	Length of Sewer completed Sept. 30, 1897.	Date of Completion named in Contract.
29	Cambridge,	Lindsay & Cudmore,	5,157	$\left\{ \begin{array}{l} 4' \times 4' 6'' \\ 3' 8'' \times 4' 2'' \\ 3' 6'' \times 4' 1'' \end{array} \right.$	$\left\{ \begin{array}{l} 16.2 \\ 12.9 \\ 18.0 \end{array} \right.$	5,157	Nov. 30, 1893
30	Cambridge,	Jones & Meehan,	7,032	$\left\{ \begin{array}{l} 3' 5'' \times 3' 8'' \\ 2' 10'' \times 3' 3'', 2' 8'' \times 2' 10'', \\ 2' 3'' \times 2' 4'', \end{array} \right.$	$\left\{ \begin{array}{l} 13.8 \\ 15.6 \\ 12.7 \end{array} \right.$	7,032	April 30, 1894
31	Charlestown,	Metropolitan Construction Co.,	4,509	$\left\{ \begin{array}{l} 2' 5'' \times 3' 1'' \\ 3' 1'' \times 3' 8'', \\ 2' 7'' \times 3' 3'', 1' 3'', \end{array} \right.$	$\left\{ \begin{array}{l} 27.4^* \\ 31.8^* \\ 23.7 \end{array} \right.$	4,509	Nov. 30, 1894
32	Charlestown,	Metropolitan Construction Co.,	4,705	$\left\{ \begin{array}{l} 2' 7'' \times 3' 3'' \\ 2' 5'' \times 3' 1'', 2' 3'' \times 3', \\ 2' 1'' \times 2' 10'', \\ 1' 7'' \times 2' 4'', \end{array} \right.$	$\left\{ \begin{array}{l} 29.5 \\ 19.0 \\ 16.8 \\ - \end{array} \right.$	869 2,214 678 944	Nov. 30, 1894
32	Charlestown Navy Yard,	Day work,	1,572	$\left\{ \begin{array}{l} 2' 1'' \times 2' 10'', \\ 1' 10'' \times 2' 7'', 1' 7'' \times 2' 4'', \end{array} \right.$	$\left\{ \begin{array}{l} 19.2^* \\ 16.8^* \\ - \end{array} \right.$	992 580	-
35	Charlestown, Somerville and Medford,	James Heath & Son,	8,370	$\left\{ \begin{array}{l} 3' 4'' \times 4' 1'', 3' 3'' \times 3' 11'', 2' 11'' \times 3' 7'', \\ 1' 10'' \times 2' 3'', \end{array} \right.$	$\left\{ \begin{array}{l} 29.0^* \\ 29.0^* \\ 21.7 \end{array} \right.$	*214 13,872 *4,230 154	Nov. 30, 1894
36	East Boston,	National Construction Co.,	237	1' 3" vitrified pipe,	18.5	237	Sept. 30, 1894
37	East Boston,	John Sheehan,	4,882	$\left\{ \begin{array}{l} 3' 4'' \times 3' 9'', \\ 3' \times 3' 5'', \end{array} \right.$	$\left\{ \begin{array}{l} 30.0 \\ 26.5^* \\ 31.0^* \end{array} \right.$	*2,144 12,738	June 30, 1894

37½ East Boston,	. . . . .	Day work,	. . . . .	276	3' 5"×3' 10",	. . . . .	29.0†	276	-
38 East Boston,	. . . . .	James Heath & Son,	. . . . .	8,229	{ 3'×3' 5", 2' 6", 1' 6", 1' 3", 1',	. . . . .	{ 24 21 20 18	8,229	Nov. 15, 1894
39 East Boston,	. . . . .	Metropolitan Construction Co.,	. . . . .	6,944	{ 1' 6", 1' 3", 1',	. . . . .	{ 21 14.5	6,944	Oct. 30, 1894
40 Everett and Malden,	. . . . .	R. A. Malone & Sons,	. . . . .	6,252	3' 9"×4' 1",	. . . . .	16.0	6,252	Aug. 31, 1892
41 Malden and Melrose,	. . . . .	Moulton & O'Mahoney,	. . . . .	9,793	2' 1"×3' 2", 1' 10"×2' 9", 1' 8"×2' 6",	. . . . .	13.0	9,793	Sept. 29, 1893
41 Malden,	. . . . .	Day work,	. . . . .	1,014	2' 1"×3' 2", 1' 8"×2' 6",	. . . . .	10.0	1,014	-
42 Melrose and Stoneham,	. . . . .	David L. Clements,	. . . . .	3,050	1' pipe,	. . . . .	11.4	3,050	Nov. 30, 1892
43 Somerville and Cambridge,	. . . . .	Metropolitan Construction Co.,	. . . . .	14,450	{ 2' 11"×3' 6", 2' 5"×3' 1", 2' 3"×2' 11", 1' 11"×2' 9", 1' 6" pipe, 1' 3" pipe,	. . . . .	{ 20.0* 26.0† 10.5* 16.0† 7.0	14,450	Oct. 31, 1893
43½ Medford and Somerville,	. . . . .	Metropolitan Construction Co.,	. . . . .	2,312	3'×3' 7", 2' 11"×3' 6",	. . . . .	13.1	2,312	Aug. 31, 1893
43½ Siphon, Mystic River,	. . . . .	Day work,	. . . . .	150	6'×7' sand-catcher, 2' pipe siphon,	. . . . .	-	150	-
44 Winchester,	. . . . .	Jones & Meehan,	. . . . .	5,608	2' 7"×2' 11", 2' 3'×2' 6", 2'×2' 5",	. . . . .	{ 13.6* 20.0†	5,354 1,254	Nov. 30, 1893
44½ West Medford and Winchester,	. . . . .	Weaving, Booth & Co.,	. . . . .	5,605	2' 11"×3' 3", 2' 9"×3' 1",	. . . . .	12.0	5,605	Mar. 31, 1894
44½ Siphon, Abajona River,	. . . . .	Abandoned contract work,	. . . . .	80	6'×14' sand-catcher, 1' 8" pipe siphon,	. . . . .	4.0	80	-
45 Winchester,	. . . . .	Everson & Liddle,	. . . . .	6,508	2'×2' 5", 1' 10"×2' 3",	. . . . .	9.6	6,508	Sept. 30, 1893
46 Winchester, Woburn and Stoneham,	. . . . .	Charles Linchan,	. . . . .	5,757	{ 1' 10"×2' 3", 1' 6"×2', 1' 3" pipe,	. . . . .	{ 10.0 8.7* 21.0†	5,757	Aug. 31, 1893
47 Winchester and Woburn,	. . . . .	Lindsey & Cudmore,	. . . . .	4,510	1' 8", 1' 6", 1' 3" pipe,	. . . . .	8.0	4,510	Aug. 31, 1894
48 Somerville, Arlington and Medford,	. . . . .	Day work,	. . . . .	1,587	{ Decatur Street, 1' 6" pipe, Jerome Street, 1' pipe, Boston Avenue, 10" pipe,	. . . . .	{ 4.56 5.53 5.78	4.56 5.53 5.78	-

* Trench.

† Tunnel.

Table showing Locations, Lengths, Depths and Sizes of Sewers, etc. — Concluded.

Section.	LOCALITY.	NAME OF CONTRACTOR.	Total Length of Section. Feet.	SIZE OF SEWER.	Average Depth of Trench, Bottom of Underdrain or Deeper Excavation. Feet.	Length of Sewer completed Sept. 30, 1897. Feet.	Date of Completion named in Contract.
49†	Melrose,	-	3,888	{ 1' 3", 1' 6", 1' 8", 2',	{ 18.0 17.0 12.5 13.2	{ 343.15 2,704.25 29.20 811.40 }	-
50	Melrose and Wakefield,	John Booth Co.,	4,663	{ 1' 6"×1' 8", 1' 6", 1' 3", 1,	{ 9.0 11.0 12.0 18.0 }	3,708	Nov. 1, 1897
51	Melrose and Stoneham,	A. W. Bryne Construction Co.,	4,123	10" to 1',	{ 9.5* 23.0†	{ 3,118 110 }	Jan. 1, 1898
12	Dorchester,	Day work,	985	3'×3' 1",	{ 16.0* 26.0†	{ 602 383 }	-
13	Dorchester,	H. P. Nawn,	3,800	3'×3' 1",	{ 11.8* 18.6†	{ 3,408 392 }	Oct. 1, 1896
14	Dorchester,	H. P. Nawn,	1,928	{ 3'×3' 1", 2' 6"×2' 7",	{ 10.2 14.3 }	1,928	Oct. 1, 1896
15	Dorchester and Hyde Park,	H. P. Nawn,	2,470	{ 2' 6"×2' 7", 4' 6"×4' 7",	{ 15.6* 18.9* 24.9†	{ 1,464 507 499 }	Dec. 1, 1896
16	Hyde Park,	H. P. Nawn,	2,379	{ 4' 6"×4' 7", 4' 3"×4' 4",	{ 26.5* 27.9† 22.2*	{ 1,247 463 669 }	Dec. 1, 1896

17	Hyde Park,	. . . . .	Geo. R. Newman & Co.,	. . . . .	1,768	4' 3"×4' 4",	. . . . .	{	16.0*	1,283 {	Jan. 1, 1897
									30.4†	486 }	
18	Hyde Park,	. . . . .	Troy Public Works Co.,	. . . . .	2,719	4' 3"×4' 4",	. . . . .	{	16.5*	2,630 {	Jan. 1, 1897
									23.0†	89 }	
19	Hyde Park,	. . . . .	Geo. S. Good & Co.,	. . . . .	2,651	{ 4' 3"×4' 4",	. . . . .	{	19.3 {	2,651 {	Jan. 1, 1897
						{ 4' 3"×4' 1",	. . . . .		16.5 }		
20	Hyde Park,	. . . . .	Geo. S. Good & Co.,	. . . . .	3,213	4' 3"×4' 1",	. . . . .	. . . . .	15.8	3,213	Feb. 1, 1897
21	Hyde Park and Dedham,	. . . . .	Mathers & Sullivan,	. . . . .	3,599	4' 3"×4' 1",	. . . . .	. . . . .	12.0	3,599	April 1, 1897
22	Dedham,	. . . . .	Mathers & Sullivan,	. . . . .	2,404	4' 3"×4' 1",	. . . . .	. . . . .	16.0	2,404	April 1, 1897
23	Dedham,	. . . . .	Haskin & Murphy,	. . . . .	2,600	4' 3"×4' 1",	. . . . .	. . . . .	{ 14.5* {	863 {	June 1, 1897
									24.0†	1,728 }	
24	Dedham,	. . . . .	Haskin & Murphy,	. . . . .	2,470	{ 4' 3"×4' 1",	. . . . .	{	20.0†	81 {	June 1, 1897
						{ 3' 9"×3' 10",	. . . . .		19.0*	1,415 }	
									20.0†	969 }	
25	Dedham,	. . . . .	E. W. Everson,	. . . . .	2,666	3' 9"×3' 10",	. . . . .	. . . . .	22.5	2,666	April 1, 1897
26	Dedham and West Roxbury,	. . . . .	National Contracting Co.,	. . . . .	4,075	{ 2' 10"×2' 11",	. . . . .	{	15.0* {	544 {	Mar. 1, 1898
						{ 3' 9"×3' 10",	. . . . .		17.3†	363 }	
27	West Roxbury,	. . . . .	National Contracting Co.,	. . . . .	3,440	2' 10"×2' 11",	. . . . .	. . . . .	12.0	1,744	June 1, 1898
28	West Roxbury,	. . . . .	Felton & Holbrook, Cabot & Daly,	. . . . .	4,567	{ 2' 8",	. . . . .	{	10.0 {	3,347 {	April 1, 1898
						{ 2' 2",	. . . . .		6.7	1,220 }	
29	West Roxbury,	. . . . .	Dennis F. O'Connell,	. . . . .	4,716	{ 2' 2",	. . . . .	{	13.0 {	454 {	June 1, 1898
						{ 1' 8",	. . . . .		10.0	1,948 }	
						{ 1' 3",	. . . . .		10.5	2,156 }	
						{ 1',	. . . . .		16.5	158 }	

* Trench.

† Tunnel.

‡ This section of sewer was purchased from the town of Melrose.

OFFICE AND GENERAL ASSISTANTS.

In addition to the assistant engineers and other assistants above referred to, the following have been employed for the whole and parts of the year : —

Assistant Engineers : —

Charles H. Swan,* special hydraulic studies and calculations.

Winslow Blanchard,* mechanical studies, maintenance and equipment of pumping stations.

Frederick D. Smith, in charge of contract construction and maintenance, Neponset Valley System.

Frank I. Capen, in charge of day work and contract construction, and maintenance studies.

Francis L. Sellev, in charge of surveys and draughting.

Charles E. Hathaway, in charge of records.

Assistants on Maintenance Studies. — Theodore Horton, B. A. Clark,† E. W. Brown.

Assistants employed on Surveys. — A. G. Adams,† H. L. Morrow,† J. C. Bell.†

Draughtsmen : —

William J. Watkins.†

Frank A. Emery.

Arthur H. Pratt.†

Harry C. Dove.†

Richard J. McNulty.

I. M. Beard.†

Stenographer. — Henry P. Fielding.

Cement Tester. — Nelson A. Hallett.‡

Messenger. — Madison C. Lewis.

* Engaged for a part of his time only, and for but a portion of the year, by the Metropolitan Sewerage Commission.

† For a portion of the year.

‡ Engaged for a portion of his time only by the Metropolitan Sewerage Commission.

MAINTENANCE.

The Metropolitan Sewerage Works comprise three distinct systems or groups of main intercepting sewers. The North Metropolitan System is mainly in the valley of the Mystic River, and discharges into the sea at Deer Island; the Charles River Valley System, along the southerly shore of the Charles River, connects with the Boston Main Drainage Works at Gainsborough Street; the Neponset River Valley System, in the valleys of Mother Brook and the Neponset River, connects with the Boston Main Drainage Works in Dorchester. The sewage from the two latter systems is carried to Moon Island, together with the sewage of Boston, and is there discharged into the sea.

North Metropolitan System. — The North Metropolitan System provides an outlet for the sewers of Woburn, Stoneham, Winchester, Arlington, Belmont, part of Wakefield, Somerville, Cambridge, Medford, Melrose, Malden, Everett, Chelsea, Charlestown, East Boston and Winthrop. It consists of about 46 miles of main and branch lines of intercepting sewers. The most distant point is about 18 miles from the outlet at Deer Island, near the line between Stoneham and Woburn. Commencing at this point as a 15-inch pipe, about 47 feet above mean low water, the sewer passes through Winchester, crossing the Abbajona River by a 20-inch masonry siphon, and through part of Medford, gradually increasing in size to 40 by 42 inches at West Medford, where it is about 8 feet above mean low water. Here it receives the sewage of the Alewife Brook branch, which conveys sewage from Arlington, Belmont and parts of Cambridge, Somerville and Medford. The Alewife Brook branch begins as a 15-inch pipe in Belmont, at an elevation of about 7 feet above mean low water, and increases in size to 36 by 43 inches near the Mystic River, where its elevation is about $2\frac{1}{2}$ feet below mean low water. The sewage is here raised about 13.5 feet to the upper-level sewer by centrifugal pumps at the Alewife Brook pumping station. After passing under the Mystic River in a 24-inch masonry siphon, it flows into the main interceptor at West Medford. Below West Medford the interceptor passes through Medford Square, along Riverside Avenue, through the marshes near Wellington to Malden River, increasing to 56 by 61 inches.

It passes Malden River by a 42-inch masonry siphon reinforced with wooden hoops and resting on piles.

In Everett, east of Malden River, the sewer receives the branch line from Malden and Melrose. The size is here increased to 70 by 76 inches, which it retains until it receives the branch sewer from Cambridge. The sewer is here about 6 feet below mean low water.

The Cambridge branch interceptor conveys the sewage from most of Cambridge and Somerville, part of Medford and all of Charlestown. It begins 27 by 28 inches in diameter in the west side of Cambridge, near Mt. Auburn, at an elevation of about 5.5 feet above mean low water, and extends along the northerly shore of the Charles River to Portland Street, Cambridge; through Portland Street, the grounds formerly of the McLean Asylum, Somerville, and Sullivan Square, Charlestown, to the southerly side of the Mystic River, where it increases to 79 by 89 inches, passing under the river by a 60-inch masonry siphon.

On the northerly side of the Mystic River is the Charlestown pumping station, where the sewage of the Cambridge branch is raised by submerged centrifugal pumps about 8 feet to the upper interceptor, which unites with the main interceptor in Everett.

The latter continues through Everett and Chelsea, increasing in size to 100 by 110 inches at Chelsea Creek. The sewer passes under Chelsea Creek by a 67-inch masonry siphon. The principal branch sewer from East Boston unites with the main on the southerly side of Chelsea Creek.

The East Boston pumping station is located just south of Chelsea Creek. All the sewage of the main line is here raised about 15 feet by submerged centrifugal pumps. The sewer at this point is nearly circular and 109 inches in diameter. The main sewer passes under Belle Isle Inlet by a masonry siphon in three channels, each 57 inches in diameter, only one of the channels being at present in use. It then resumes its former size, and continues through Winthrop to Shirley Gut, which it crosses by means of a 73-inch masonry siphon.

The sewer on Deer Island, between Shirley Gut and the pumping station, is 109 inches in diameter. The elevation of the sewer at the pumping station is about 7.6 feet below mean low water. The sewage is here raised by means of submerged centrifugal pumps. The lift varies with the stage of the tide, being about 11 feet on an average, with a maximum lift of about 20 feet.

The outfall sewer into which the pumps discharge is 6 feet wide, and varies in height from 10 feet at the pumping station to 6 feet at the shore. It is continued about 1,800 feet beyond the shore line to a point near the Deer Island light-house, where it turns

upwards and discharges the sewage into the sea. This discharge is continuous through all stages of the tide.

Charles River System. — The Charles River System provides an outlet for the local sewers of Waltham, Watertown, most of Newton, Brighton, most of Brookline and a part of the Back Bay district of Boston. It consists of about 8 miles of intercepting sewers. The upper end in Waltham is 42 by 48 inches and about 21 feet above mean low water. It follows generally along the southerly side of the Charles River to the corner of Gainsborough Street and Huntington Avenue in Boston, where it is 78 inches in diameter and about 5 feet below mean low water. Below this point the sewage flows by gravity through the sewers of the Boston Main Drainage Works, is pumped with the Boston sewage and is discharged into Boston harbor at Moon Island.

Neponset Valley System. — The Neponset Valley System provides an outlet for the local sewers of districts in West Roxbury, Dedham, Hyde Park, Milton and Dorchester. It is expected that those districts of Newton and Brookline which cannot be connected with the Charles River Valley System will eventually be made a part of the Neponset Valley System, as they naturally drain to it. The sewage will ultimately be discharged into the sewers of the Boston Main Drainage Works in Dorchester, near Granite bridge, and be pumped with the Boston sewage and discharged at Moon Island in Boston harbor. The system now consists of about 10 miles of intercepting sewers. The upper end in West Roxbury on Weld Street, near the Brookline town line, is 15 inches in diameter and about 116 feet above mean low water. It follows southerly in private lands in the brook valley to Newfield Street, through St. Joseph's Cemetery and along the Brookline water works' taking to a point on the northerly shore of the Charles River at Gardner Street, near the Brookline water works pumping station, thence along the northerly shore of the Charles River, Mother Brook and the Neponset River through West Roxbury, Dedham and Hyde Park. In the lower part of Hyde Park its size is 54 by 55 inches and its elevation is about 31 feet above mean low water.

It is expected that before many years the portion of this system above the lower part of Hyde Park will be made a branch of a high-level gravity sewer yet to be built.

Through Dorchester to Central Avenue the sewer is made to conform to the capacity of the Dorchester Interceptor, which forms a temporary outlet for the part of the Neponset System above the future point of connection with the high-level gravity sewer; it is about 36 inches in diameter, and at Central Avenue is about 20 feet above mean low water.

The maintenance of the Metropolitan Sewerage Works involves the operation of the four pumping stations, the care of the 65 miles of intercepting sewers, siphons and other connected structures, and engineering studies for extensions and care of the works. A detailed statement in relation to maintenance follows.

NORTH METROPOLITAN SYSTEM.

The pumping plants at all the stations have been in continuous operation during the year and are now in excellent condition. The quantity of sewage pumped has very largely increased during the year, due to a more extended use of the system by the tributary cities and towns. The following table gives data in relation to the connected areas : —

NORTH METROPOLITAN SYSTEM.

Table showing Cities and Towns delivering Sewage to this System; Approximate Miles of Sewer connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

CITIES AND TOWNS.	Miles of Local Sewer connected.	Separate or Combined.	Number of Connections with Local Sewers.	Estimated Number of Persons served per Each House-Connection *	Estimated Population now contributing.	Estimated Area now contributing Sewage.	Square Miles.	Area ultimately to contribute Sewage.	Ratio of Contributing Population to Present Total Population.	Per Cent.	Ratio of Contributing Area to Ultimate Area.
Roston (Deer Island), .	0.20	Separate, .	-	-	1,400†	-	-	-	-	-	-
Winthrop, .	21.01	Separate, .	1,198	3.6	4,313	1.01	1.61	1.61	90.5	62.8	62.8
Boston (East Boston), .	1.26	Separate and combined.	147	8.8	1,294	0.06	2.18	2.18	2.9	2.8	2.8
Chelsea, .	1.68	Combined, .	242	6.4	1,550	0.08	2.24	2.24	4.7	3.6	3.6
Everett, .	9.74	Separate, .	614	5.3	3,254	0.64	3.34	3.34	15.1	19.2	19.2
Malden, .	35.00	Separate, .	2,246	5.3	11,904	2.26	5.07	5.07	36.5	44.5	44.5
Melrose, .	26.43	Separate, .	898	4.3	3,861	1.20	3.73	3.73	29.0	32.3	32.3
Boston (Charlestown), .	5.46	Separate and combined.	1,700	8.1	14,000‡	0.16	1.27	1.27	34.6	12.6	12.6
Cambridge, .	103.36	Separate and combined.	12,585	6.5	81,800	4.82	6.11	6.11	95.0	79.0	79.0
Somerville, .	69.60	Separate and combined.	10,138	5.5	55,759	3.08	3.96	3.96	97.8	78.0	78.0
Medford, .	41.06	Separate, .	1,329	5.2	6,911	2.00	8.35	8.35	43.6	24.0	24.0
Winchester, .	14.01	Separate, .	278	5.3	1,473	0.72	5.95	5.95	22.1	12.1	12.1
Woburn, .	10.75	Separate, .	570§	5.6	3,192	0.85	12.70	12.70	22.1	6.7	6.7
Stoneham, .	9.06	Separate, .	96	4.6	442	0.52	5.50	5.50	7.0	9.5	9.5
Arlington, .	11.07	Separate, .	171	5.4	923	1.06	5.20	5.20	13.5	20.4	20.4
Belmont, .	4.34	Separate, .	79||	5.7	835||	0.65	4.66	4.66	26.6	14.0	14.0
Wakefield,¶	-	Separate, .	-	-	-	-	0.95	0.95	-	-	-
	364.03	-	32,291	5.7	192,911	19.11	72.82	72.82	49.8	26.3	26.3

* This is estimated from assessors' statement of the number of houses in each city or town, and the population from census of 1895 extended to 1897.

† Estimated by Superintendent J. R. Gerrish of the Institution on Deer Island.

‡ Including 30 persons at navy yard.

§ Exclusive of Mystic Valley Sewer and tanneries. || Including 2 connections with McLean Hospital, having an estimated population of 400. ¶ Wakefield not connected.

Approximately 364 miles of local sewers are now connected with this system, used by 193,000 people, or about 50 per cent. of the total resident population on the area. All the cities and towns within the area have made some use of the system except Wakefield. The quantity of sewage pumped at each station is indicated in the accompanying tables, together with lifts and pump duties:—

Table of Approximate Quantities and Lifts, Deer Island Pumping Station, North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (Million ft.-lbs. per 100 lbs. Coal).
1896-97.						
October, .	561,645,000	18,118,000	13,331,000	30,218,000	10.78	46,600,000
November, .	642,812,000	21,427,000	14,090,000	31,350,000	10.66	53,500,000
December, .	816,606,000	26,342,000	21,050,000	40,508,000	10.85	62,100,000
January, .	943,664,000	30,441,000	23,996,000	44,530,000	10.62	66,130,000
February, .	1,024,692,000	36,596,000	27,758,000	55,380,000	11.12	75,500,000
March, .	1,161,790,000	37,477,000	30,756,000	45,920,000	10.91	65,700,000
April, .	1,138,564,000	37,952,000	31,494,000	55,768,000	10.72	62,900,000
May, .	1,014,433,000	32,724,000	28,788,000	41,330,000	10.87	55,800,000
June, .	1,126,530,000	37,551,000	28,788,000	64,256,000	10.99	59,800,000
July, .	1,075,373,000	34,699,000	29,066,000	43,894,000	10.80	63,400,000
August, .	1,125,568,000	36,309,000	32,216,000	47,134,000	10.85	66,300,000
September, .	978,254,000	32,609,000	22,708,000	41,734,000	10.84	60,000,000
Total, .	11,609,931,000	-	-	-	-	-
Average, .	-	31,853,000	25,337,000	45,169,000	10.83	61,478,000

Table of Approximate Quantities and Lifts, East Boston Pumping Station, North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (Million ft.-lbs. per 100 lbs. Coal).
1896-97.						
October, .	509,994,000	16,451,000	12,119,000	27,471,000	14.36	39,900,000
November, .	584,048,000	19,468,000	12,790,000	28,400,000	14.26	45,300,000
December, .	754,606,000	24,342,000	19,050,000	38,508,000	14.59	51,540,000
January, .	881,664,000	28,441,000	21,996,000	42,530,000	15.05	57,210,000
February, .	968,692,000	34,596,000	25,758,000	53,380,000	15.22	60,200,000
March, .	1,115,290,000	35,977,000	29,256,000	44,420,000	14.84	61,400,000
April, .	1,093,564,000	36,452,000	29,994,000	54,268,000	15.09	61,200,000
May, .	977,937,000	31,546,000	25,956,000	39,830,000	14.68	53,600,000
June, .	1,081,530,000	36,051,000	27,288,000	62,756,000	14.69	55,700,000
July, .	991,235,000	31,975,000	26,352,000	41,180,000	14.90	62,700,000
August, .	1,041,434,000	33,595,000	29,502,000	44,420,000	14.97	62,600,000
September, .	896,834,000	29,894,000	24,800,000	39,020,000	15.12	59,200,000
Total, .	10,896,828,000	-	-	-	-	-
Average, .	-	29,899,000	23,738,000	43,015,000	14.81	55,879,000

Table of Approximate Quantities and Lifts, Charlestown Pumping Station, North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (Million ft.-lbs. per 100 lbs. Coal).
1896-97.						
October, .	313,348,000	10,108,000	8,078,000	20,661,000	7.72	34,000,000
November, .	374,401,000	12,480,000	8,250,000	20,000,000	7.82	40,800,000
December, .	497,842,000	16,059,000	11,200,000	28,113,000	7.97	49,990,000
January, .	618,839,000	19,963,000	16,234,000	31,802,000	7.88	55,640,000
February, .	630,718,000	22,526,000	16,387,000	42,826,000	7.94	54,500,000
March, .	699,312,000	22,558,000	18,216,000	30,580,000	7.40	55,400,000
April, .	692,478,000	23,082,000	17,301,000	41,836,000	8.15	58,400,000
May, .	696,074,000	22,454,000	17,149,000	29,014,000	8.17	58,100,000
June, .	752,544,000	25,085,000	17,758,000	44,212,000	8.24	61,300,000
July, .	770,070,000	24,841,000	20,416,000	34,266,000	8.50	68,800,000
August, .	823,660,000	26,569,000	22,000,000	35,400,000	7.84	70,800,000
September, .	665,169,000	22,172,000	14,866,000	31,000,000	7.13	64,500,000
Total, .	7,534,455,000	-	-	-	-	-
Average, .	-	20,658,000	15,655,000	32,476,000	7.90	56,019,000

Table of Approximate Quantities and Lifts, Alewife Brook Pumping Station, North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (Million ft.-lbs. per 100 lbs. Coal).
1896-97.						
October, .	46,977,000	1,515,000	1,034,000	3,231,000	12.51	9,640,000
November, .	49,744,000	1,658,000	1,165,000	2,718,000	12.58	9,770,000
December, .	70,564,000	2,276,000	1,783,000	4,196,000	11.65	13,140,000
January, .	74,711,000	2,410,000	1,580,000	3,526,000	11.79	13,600,000
February, .	80,867,000	2,888,000	2,120,000	4,085,000	11.76	15,430,000
March, .	107,423,000	3,465,000	2,645,000	4,554,000	11.81	19,100,000
April, .	101,716,000	3,391,000	2,598,000	4,677,000	13.02	21,700,000
May, .	79,661,000	2,569,000	1,994,000	3,622,000	13.17	17,600,000
June, .	87,653,000	2,922,000	1,868,000	4,860,000	12.92	18,000,000
July, .	75,257,000	2,428,000	1,951,000	3,730,000	12.93	15,000,000
August, .	82,209,000	2,652,000	1,952,000	3,968,000	12.90	15,900,000
September, .	68,509,000	2,284,000	1,741,000	3,379,000	12.95	15,350,000
Total, .	925,291,000	-	-	-	-	-
Average, .	-	2,538,000	1,869,000	3,879,000	12.50	15,352,000

In the fourth annual report (1893, pages 125-128) appears a graphic statement of quantities of sewage anticipated in future years at the North Metropolitan pumping stations. The issue of this report being now exhausted, the diagrams and explanatory text are here reproduced for comparison with quantities pumped during the past year:—

ESTIMATED QUANTITY OF SEWAGE.

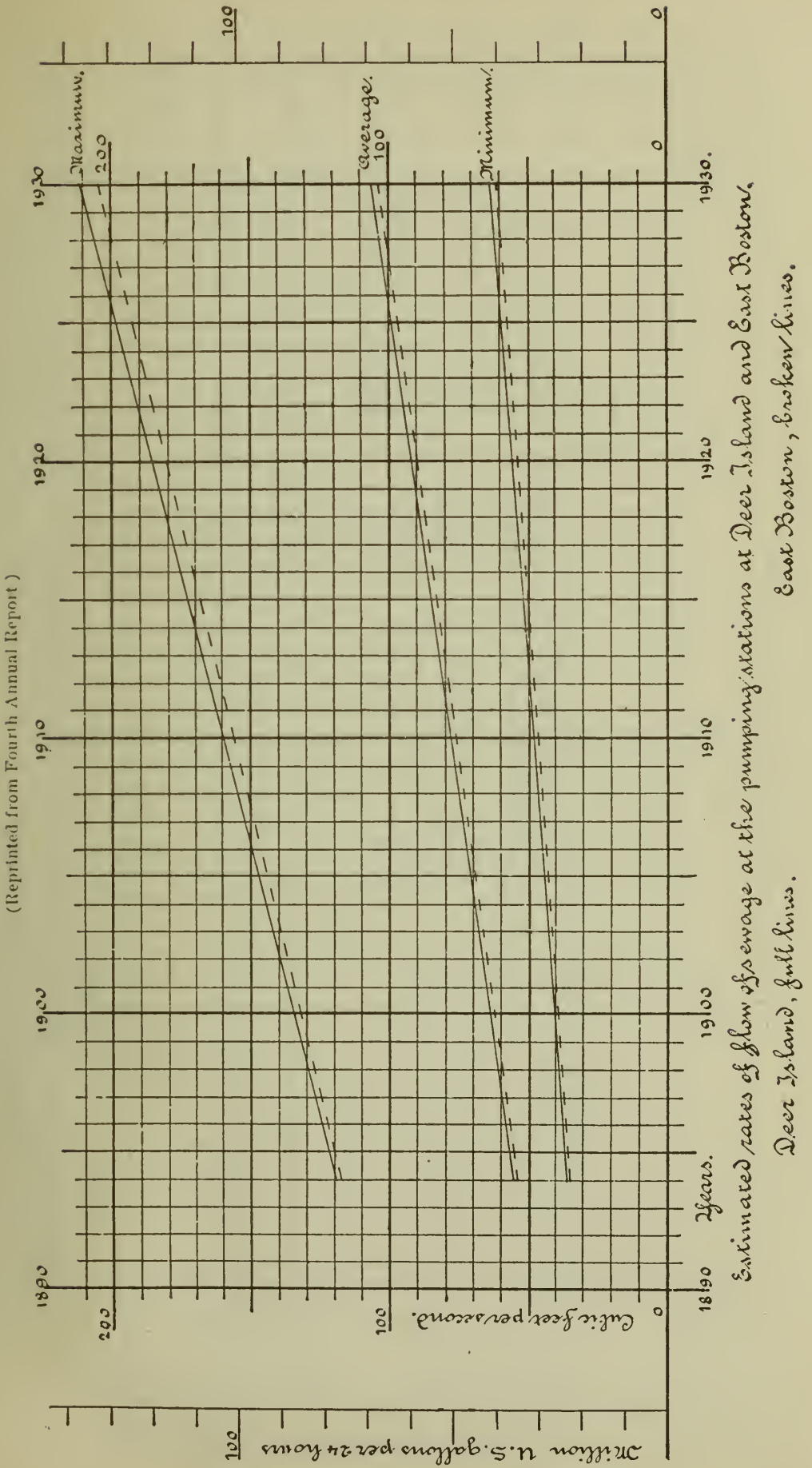
The sizes of sewers in the preliminary design of the Metropolitan System were based on the estimates of population made by the State Board of Health (see Senate Document No. 2, January, 1889, page 41). These estimates were based upon the census of 1885 and those of earlier years. After the work of construction of the system was begun the figures derived from the census of 1890 showed that the population of the district was growing more rapidly than had been indicated by the earlier census. The estimate of the population in 1930 was therefore revised and increased. The estimated amount of sewage for 1930, as given in the above-mentioned Senate Document, is about 10 per cent. less than that finally adopted. The sizes of the sewers in our system have been accordingly increased, adding somewhat to the cost of construction.

The maximum rate of flow is taken at 35 cubic feet, or 262 gallons, per head per day for Somerville and Cambridge, and at 30 cubic feet, or 224 gallons, per head per day for all other cities and towns.

The average rate of flow is taken at 110 gallons per head per day for the population of 1890 and at 120 gallons per head per day for the anticipated population of 1930, the population and rate of flow being considered to increase at a uniform ratio between these years.

The minimum rate of flow is taken at two-thirds the average flow in dry seasons. This ratio is derived from some observations upon the flow of sewers in Providence. The average flow in dry seasons is estimated at 117 gallons per head per day in city districts, and at 85 gallons per head per day in suburban districts (see page 95 of the above-mentioned Senate Document). The minimum rate of flow is therefore taken at 78 gallons per head per day for Boston, Charlestown, East Boston, Chelsea, Somerville and Cambridge, and at 57 gallons per head per day for all the other cities and towns. Reports of the flow of sewage at the Boston main drainage pumping station indicate that the minimum rate of flow in 1889 at that place was about 82 gallons per head per day. The rates of flow of sewage at the several pumping stations are computed on the supposition that the entire estimated population is connected with the sewers.

Appended diagrams show the estimated rates of flow for a period of forty years at the pumping stations of the North Metropolitan System in cubic feet per second and also in million gallons per twenty-four hours.



(Reprinted from Fourth Annual Report.)

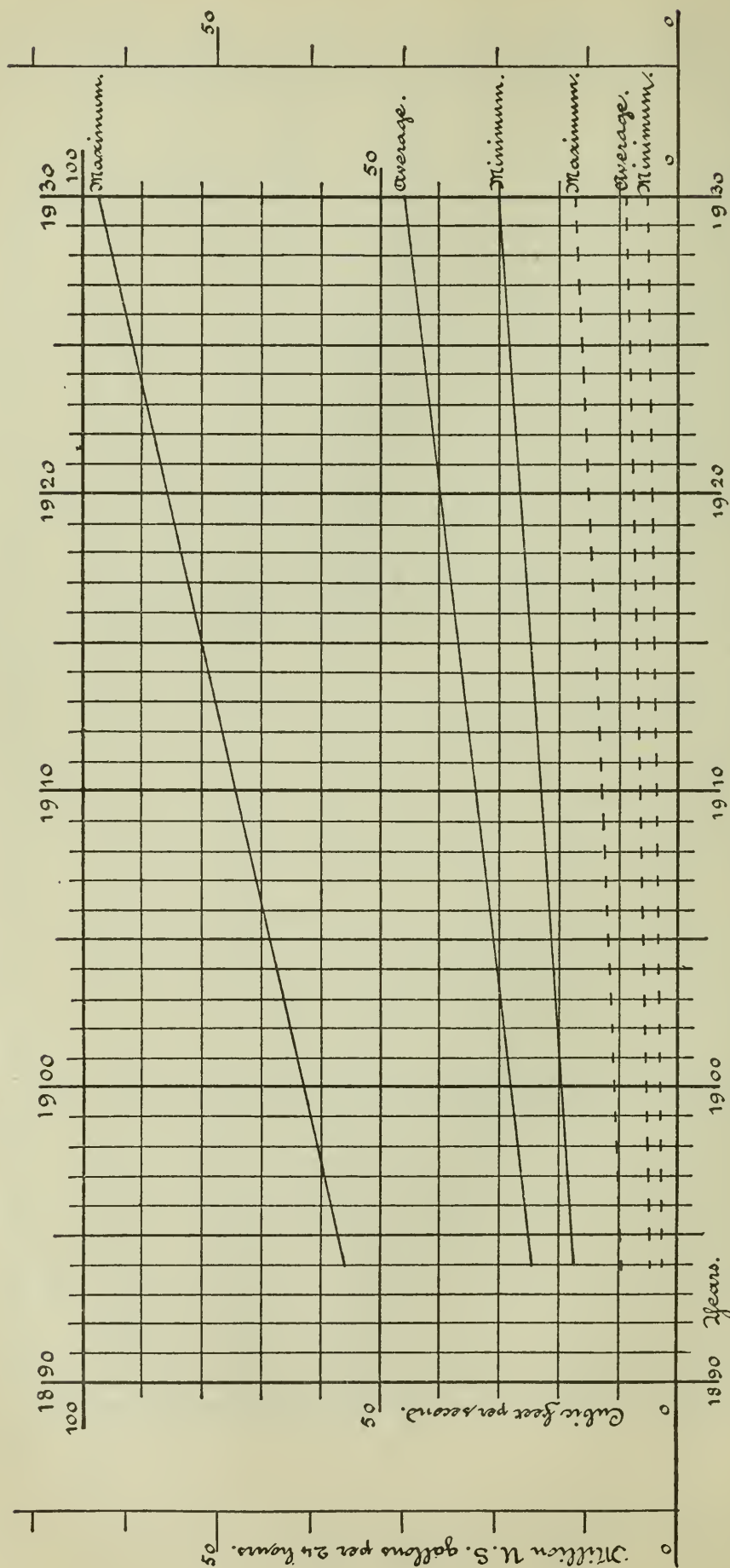


Table showing Comparison between Anticipated and Actual Quantities pumped at North Metropolitan Pumping Stations during the Year ending Sept. 30, 1897.

PUMPING STATION.	AVERAGE.		MAXIMUM.		MINIMUM.	
	Actual Quantities.	Anticipated Quantities.	Actual Quantities.	Anticipated Quantities.	Actual Quantities.	Anticipated Quantities.
Deer Island,	31,853,000	38,250,000	45,169,000	82,000,000	25,337,000	24,500,000
East Boston,	29,899,000	37,000,000	43,015,000	80,500,000	23,738,000	23,000,000
Charlestown,	20,658,000	17,000,000	32,476,000	38,250,000	15,655,000	12,000,000
Alewite Brook,	2,538,000	3,000,000	3,879,000	6,500,000	1,869,000	1,800,000

At all stations except Charlestown the anticipated quantities have exceeded actual amounts pumped. At Charlestown the excess is largely manufacturing wastes, for which special payments are made and which will probably be much reduced in the future.

COST OF PUMPING.

The quantities of sewage handled at the large stations during the latter half of the year exceed 50 per cent. of the working capacities of the pumps. The average cost per million foot-gallons, shown in the accompanying tables, is commendably low, comparing favorably with results obtained from high-grade reciprocating pumps. During the first half of the year the pumping was light. It may reasonably be anticipated that the present cost per million foot-gallons will be considerably reduced in future years.

Deer Island and East Boston Pumping Stations.

At each station are two submerged centrifugal pumps, 8.25 feet in diameter, driven by triple-expansion engines of the Reynolds-Corliss type; both pumps and engines were specially designed and erected by the Edward P. Allis Company of Milwaukee, Wis.

Nominal capacity of pumps: 45,000,000 gallons each, with 12-foot and 16-foot lifts respectively at Deer Island and East Boston.
Average duty for the year: 61,000,000 and 56,000,000 foot-pounds respectively.
Average quantity raised each day: 32,000,000 and 30,000,000 gallons respectively.
Force employed at each station: 3 engineers, 3 screenmen, 3 firemen and 1 reliefman.
Coal used: first-quality Cumberland, costing from \$2.76 to \$3.05 per ton.

Average Yearly Cost per Million Foot-gallons for Pumping at Deer Island Station.

Annual Volume (11,610 Million Gallons)×Lift (10.83 Feet)=125,736 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	\$6,391 65	\$0.0509*
Coal,	2,459 63	.0196
Oil,	330 69	.0026
Waste,	42 92	.0003
Water,	457 20	.0036
Packing,	140 02	.0011
Miscellaneous supplies and renewals,	993 84	.0079
Total,	\$10,815 95	\$0.0860

* Includes labor at screens; deducting this item gives cost of labor \$0.0383.

Average Yearly Cost per Million Foot-gallons for Pumping at East Boston Station.

Annual Volume (10,896 Million Gallons) × Lift (14.81 Feet) = 161,370 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	\$6,674 98	\$0.0413*
Coal,	3,482 11	.0216
Oil,	380 56	.0024
Waste,	42 03	.0003
Water,	715 20	.0044
Packing,	74 17	.0005
Miscellaneous supplies and renewals,	1,098 21	.0068
Total,	\$12,467 26	\$0.0773

* Includes labor at screens; deducting this item gives cost of labor \$0.0333.

To compare these results with cost of pumping elsewhere, the following statement, compiled from figures given in the twenty-first annual report of the City Engineer of Boston for the year 1887, page 25, is given : —

LEAVITT HIGH-DUTY RECIPROCATING PUMPS, OLD HARBOR POINT STATION, BOSTON MAIN DRAINAGE WORKS.

Analysis of Cost of Pumping Sewage.

(See Report of the City Engineer of Boston for the year 1887.)

ITEMS.	Cost.	Cost per Million Foot-gallons.	Approx- imately.	Say —
Labor,	\$17,334 96	Cents. 3.16	Cents. 3.2	Cents. 3.0
Coal,	8,687 48	1.58	1.6	2.0
Water,	711 60	0.13	0.5	0.5
Valves,	838 82	0.15		
Gasoline,	529 05	0.09		
Oil,	500 22	0.09		
Packing,	198 61	0.04		
Waste,	49 12	0.01	0.6	0.5
Renewals,	3,316 84	0.60		
Total,	\$32,166 70	5.85	5.9	6.0

Annual volume = 43,630,657 × 365 gallons.
Average lift = 34.54 feet.
Corresponding duty, 99,560,000 foot-pounds.

This record is for the well-known Leavitt engine of the compound, beam and fly-wheel type, specially designed to give a high degree of economy in the consumption of coal. The engine was practically new, and operated under most favorable conditions. The published duty of nearly 100,000,000 foot-pounds has not since been exceeded.

The last published average yearly duty for the Boston Main Drainage Station from the report of the Superintendent of Streets for the year ending Jan. 31, 1896, was approximately 68,000,000 foot-pounds before correcting for 14 to 17 per cent. of slip.

Charlestown Pumping Station.

At this station are two submerged centrifugal pumps, 7.5 feet in diameter, driven by triple-expansion Reynolds-Corliss engines; both pumps and engines were specially designed and erected by the Edward P. Allis Company of Milwaukee, Wis.

Nominal capacity of pumps: 22,000,000 gallons each, with 8-foot lift.
Average duty for the year: 56,000,000 foot-pounds.
Average quantity raised each day: 21,000,000 gallons.
Force employed: 3 engineers, 3 screenmen, 3 firemen and 1 reliefman.
Coal used: first-quality Cumberland, costing from \$2.79 to \$3.05 per ton.

Average Yearly Cost per Million Foot-gallons for Pumping at Charlestown Station.

Annual Volume (7,534 Million Gallons)×Lift (7.9 Feet)=59,519 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	\$6,497 68	\$0.1092
Coal,	1,449 97	.0244
Oil,	386 41	.0065
Waste,	47 73	.0008
Water,	243 30	.0041
Packing,	46 36	.0008
Miscellaneous supplies and renewals,	961 74	.0162
Total,	\$9,633 19	\$0.1620

Because of the low lift and the relatively small quantity of sewage raised, the cost for labor per million foot-gallons at this station must always exceed that at Deer Island and East Boston, since the continuous service and the necessities of the house require a force as numerous as at the larger stations.

Alewife Brook Pumping Station.

The plant consists of small commercial pumps and engines, — two 9-inch Andrews vertical centrifugal pumps, with direct-connected compound marine engines.

Capacity of pumps : 4,500,000 gallons each, with 13-foot lift.
Average duty for the year : 15,000,000 foot-pounds.
Average quantity raised each day : 2,540,000 gallons.
Force employed : 2 engineers working 12-hour shifts each.
Coal used : first-quality Cumberland, costing from \$3.43 to \$4.07 per ton.

Average Yearly Cost per Million Foot-gallons for Pumping at Alewife Brook Station.

Annual Volume (925 Million Gallons)×Lift (12.5 Feet)=11,562 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot- gallons.
Labor,	\$2,362 64	\$0.2044
Coal,	1,073 15	.0928
Oil,	218 39	.0188
Waste,	21 22	.0019
Water,	86 80	.0075
Packing,	11 76	.0010
Miscellaneous supplies and renewals,	393 64	.0340
Total,	\$4,167 60	\$0.3605

The cost per million foot-gallons is largely for labor. This could not be reduced if a high-grade, specially designed plant were used, as two men now attend the plant for 24 hours. The small economy in coal that might be obtained from a high-duty plant would, if capitalized, be offset by the increased cost of such a plant. Owing to the very small quantity of sewage raised and the low lift, the cost per million foot-gallons here must always considerably exceed that at the larger stations.

ADDITIONAL PUMPS NEEDED.

Deer Island and East Boston Pumping Stations.

An examination of the tables of quantities pumped during the year at these stations indicates that for the last six months the average daily service is within 10,000,000 gallons of the capacity of a single pump. Large additional areas in East Boston, Chelsea and Charlestown are now about to be connected with the system, which will yield probably 20,000,000 gallons per day, thus placing the average dry-weather service of the coming year at fully the maximum capacity of a single pump, necessitating the constant operation of both pumps in case of storm or the larger deliveries of the winter months.

Experience in the erection of the existing pumping plants indicates that under the most favorable conditions two years will probably be needed to carry out the necessary construction for, and erection of, additional pumps.

Charlestown Pumping Station.

At this station the table of quantities indicates that the average daily service has already exceeded the nominal capacity of one pump. Both pumps are now operated for a considerable time in wet weather. A large additional area in Charlestown, tributary to this station, is soon to be connected with the system.

Alewife Brook Pumping Station.

The average daily service at this station now approximates 3,000,000 gallons.

Chapter 520 of the Acts of 1897 provides for the addition of the town of Lexington to that part of the Metropolitan Sewerage System tributary to the Alewife Brook Pumping Station. The addition will probably be made during the coming year. This provides for considerable areas in Arlington; and the leading main to Lexington as designed is of considerable length through wet country that will yield a large amount of ground water. It is anticipated that this extension must increase the quantity received at the station 1,500,000 gallons per day. In winter and during storms this will necessitate continuous operation of both of the existing pumps after the Lexington extension is connected.

Appropriations recommended.

It is recommended that additional appropriations for purchasing pumps and carrying out the necessary construction be requested, as follows : —

Deer Island Pumping Station : —

For the construction of a fourth pit, the erection at Pit No. 3 of one engine and pump and the introduction of a battery of two boilers, the engine, pump and boilers to be of the same general type and size as those at present in service at this station, \$43,000 00

East Boston Pumping Station : —

For the construction of a fourth pit, the erection at Pit No. 3 of one engine and pump and the introduction of a battery of two boilers, the engine, pump and boilers to be of the same general type and size as those at present in service at this station, \$44,000 00

Charlestown Pumping Station : —

For the erection at Pit No. 3 of an engine and pump of the same general type and size as at present in service at Deer Island and East Boston, the enlargement of the suction and discharge passages and the introduction of a battery of two boilers of the same general type and size as those at present in service at this station, \$46,000 00

The existing pit at the Charlestown station is of sufficient size to receive the large pump; the house itself has the same width as that at East Boston. With the very low lift at this station the large pump will have a capacity of 100,000,000 gallons per day, or the full carrying capacity of the discharge sewer.

The introduction of a large pump at this house will result in a considerable saving in cost by avoiding the construction of a fourth pit, which at this station would be very expensive, and the enlarging of the engine-room itself. It will further effect considerable economy and convenience in maintenance.

Alewife Brook Pumping Station: —

For the construction and erection of one vertical centrifugal pump,	
a direct-connected compound vertical engine and one 100-horse-	
power horizontal tubular boiler, this additional plant to have a	
capacity of 13,000,000 gallons on a 13-foot lift and a guaranteed	
duty of 50,000,000 foot-pounds,	\$9,500 00

The proposed new pump at the Alewife Brook station is designed to have the full carrying capacity of the discharge sewer. It will be needed only in case the extension to Lexington is built. If the Lexington extension is not built, the existing pumps are estimated to be sufficient for the ordinary extensions of the next five years.

Total appropriation recommended for additional pumping machinery, \$142,500.

ELECTRIC LIGHTING PLANTS.

During the year electric lighting has been introduced at East Boston and Deer Island stations, as follows: —

East Boston Pumping Station.

The plant at this station consists of belt-connected generator and high-speed engine. The dynamo is of the direct-current, multi-polar type, of $7\frac{1}{2}$ kilowatt capacity and of the Eddy Manufacturing Company's make.

The engine is an automatic Westinghouse machine, with $5\frac{1}{2}$ -inch cylinder and 5-inch stroke, rated at 10 horse-power. It was owned by the commission and has been thoroughly repaired.

The station has been wired for 60 incandescent lamps in 5 circuits, lighting the engines, boilers, coal-house, screen-room and toilet-rooms, controlled from switches located on a central switch-board in the dynamo-room.

<i>Cost.</i>	
Repairs to Westinghouse engine,	\$71 00
Generator, G. M. Angier & Co.,	247 50
Wiring and installing, James Wilkinson & Co.,	211 00
Foundations and pipe connections,	252 79
	<hr/>
	\$782 29

Deer Island Pumping Station.

The plant at this station consists of a belt-connected generator and a high-speed engine.

The dynamo is of the direct-current, multi-polar type, of 15 kilowatt capacity and of the Eddy Manufacturing Company's make.

The engine is an Armington & Sims high-speed machine, with 6½-inch cylinder and 8-inch stroke, rated at 18 horse-power. This engine, though not entirely new, had been used but very little and was in excellent condition when purchased.

The plant has a capacity of 200 16-candle-power incandescent lamps. The station has been wired for 77 lamps in 6 circuits, lighting the engines, boilers, coal-house, screen-room and toilet-rooms, controlled from switches located on a central switch-board in the dynamo-room. Provision has been made and a switch placed on the switch-board for controlling a circuit which in the future may be extended into the employees' dwelling-house located near the station.

<i>Cost.</i>	
Armington & Sims engine, Jas. H. Roberts & Co.,	\$175 00
Generator, G. M. Angier & Co.,	337 50
Wiring and installing, H. N. Bates Machine Company,	200 00
Foundations and pipe connections,	206 50
	<hr/>
	\$919 00

MAINTENANCE OF SEWERS AND SPECIAL STRUCTURES.

For the care of 42 miles of sewers and connected special structures in the North Metropolitan System a permanent force is employed, consisting of a foreman, 5 sub-foremen, 16 men and 4 horses and teams. As needed, additional men are temporarily employed. This force inspect and maintain regulators and connections, clean and flush the sewers when needed, remove ashes and screenings from the stations, maintain the station buildings and grounds, clean sand-catchers and flush siphons as needed and maintain a ferry at Shirley Gut. During the year the surface over the sewer in private lands has been graded and otherwise improved.

The cost of the above work, with necessary supplies for the year, has been \$21,666.85.

CONDITION OF THE SEWERS.

The sewers are now clean and in first-class condition. Some flushing has been required on the Mystic Valley Sewer, acquired of

the city of Boston, costing for the year \$195. In the upper ends of the branch lines, where the flow is still slight, particularly where manufacturing wastes are delivered, some flushing and hand-cleaning in the sewers was required, costing for the year \$200.

During the year the following quantity of sand and other material has been taken from the sand-catchers at the places named : —

Material taken from Sand-catchers at Siphons, North Metropolitan System.

LOCATION OF SAND-CATCHER.	Cubic Yards removed.
Shirley Gut,	2.1
Belle Isle Inlet,	26.5
Chelsea Creek,	29.9
Mystic River (Charlestown),	3.0
Malden River,	27.3
Mystic River (Somerville, near Boston Avenue),	11.0
Abbajona River,	10.0
Lake Street,	3.0
Total,	112.8

OBSERVATIONS OF LOSSES OF HEAD AT SIPHONS; CONDITION OF DEER ISLAND BAR AND OUTFALL.

Careful observations of losses of head at all the siphons have been made at frequent intervals during the year. The observations indicate that no appreciable deposits have thus far occurred.

The Deer Island bar at the outlet is free from deposit and the outfall itself is in a satisfactory condition.

TIME REQUIRED BY SEWAGE FROM VARIOUS LOCALITIES TO PASS THROUGH THE METROPOLITAN SEWERS TO THE OUTFALL NEAR DEER ISLAND LIGHT.

The time of sewage passing through the Metropolitan System to the outlet at Deer Island from various locations in the area has been studied by means of surface floats. The mean of several observations is given in the table below. The sewers at the dates of observations had a depth of flow of from 13 to 36 per cent. of their vertical diameters. Eighty per cent. of the observed surface velocity has been taken as the mean velocity of the section. The observations do not sensibly disagree with results obtained from calculations based on theoretical velocities.

It appears that tannery drainage from Woburn is delivered at the outfall in about 14 hours after being received into the Metropolitan Sewer; from Stoneham, in about 15 hours; and effluent from the packing houses in Somerville, in about 7 hours.

Table showing Results of Float Measurements to determine Probable Time required by Sewage in passing from Various Points within the North Metropolitan Area to the Outfall near Deer Island Light.

Main Line.

POINTS FROM WHICH FLOAT MEASUREMENTS WERE MADE.	Distance to Outfall measured over Centre Line of Sewer.	Time occupied by Floats in passing from Given Points to Outfall.	
	Miles.	Hours.	Minutes.
Stoneham :—			
Stoneham-Woburn line, Montvale Avenue, . . .	17.95	15	30
Woburn :—			
Baeder, Adamson & Co. (glue factory),	17.40	15	4
Woburn-Winchester line,	17.00	14	24
Winchester :—			
Cross Street, Winchester Highlands,	16.40	13	15
Common Street, Winchester Station,	15.07	11	57
Medford :—			
Bellmouth, junction of old Mystic Valley Sewer and main line, opposite dam between Upper and Lower Mystic lakes,	13.45	10	—
Bellmouth, Canal and Prescott streets, West Medford,	12.30	8	54
Medford Square,	11.30	8	—
Medford-Everett line, Malden River siphon,	9.30	6	21
Everett :—			
Bellmouth, near Faxon Street, West Everett,	8.90	5	57
Bellmouth, junction of Cambridge branch and main line near Everett Station,	8.10	5	18
Everett-Chelsea line,	7.40	4	43
Chelsea :—			
Chelsea Square,	6.73	4	17
East Boston :—			
East Boston Pumping Station,	5.70	3	34
East Boston-Winthrop line, Belle Isle Inlet siphon, .	4.25	2	43
Winthrop :—			
Winthrop Beach Station, Washington Street, . . .	3.25	1	40
Point Shirley, at Shirley Gut siphon,	1.38	1	7
Deer Island :—			
Deer Island Pumping Station,	0.70	—	35
Outfall, Deer Island Light,	—	—	—

Belmont Branch.

Belmont :—			
Belmont-Cambridge line, end of Belmont branch, .	15.00	11	54
Cambridge :—			
Bellmouth, Rindge Avenue,	14.35	10	54

Alewife Brook Branch.

Cambridge :—			
Concord Avenue, end of Alewife Brook branch, .	14.85	11	34
Massachusetts Avenue, at Alewife Brook,	13.77	10	25
Somerville :—			
Broadway, at Alewife Brook,	13.35	10	3
Alewife Brook Pumping Station,	12.78	9	14
Medford :—			
Bellmouth, junction of Alewife Brook branch and main line, Canal and Prescott streets,	12.30	8	54

*Table showing Results of Float Measurements, etc. — Concluded.**Melrose Branch.*

POINTS FROM WHICH FLOAT MEASUREMENTS WERE MADE.	Distance to Outfall measured over Centre Line of Sewer.	Time occupied by Floats in passing from Given Points to Outfall.	
Melrose:—	Miles.	Hours.	Minutes.
Junction of Wyoming Avenue and Pleasant Street, .	12.10	9	1
Melrose-Malden line,	11.25	8	8
Malden:—			
Pleasant and Middlesex streets,	10.28	7	18
Malden-Everett line,	9.32	6	26
Everett:—			
Bellmouth, opposite Faxon Street, West Everett, .	8.90	5	57

Cambridge Branch.

Cambridge:—			
End of Cambridge line, corner Mt. Auburn and Lowell streets,	14.15	11	—
Elliot Square,	13.50	9	44
Binney and Portland streets,	10.95	7	19
Cambridge and Warren streets,	10.57	7	7
Somerville:—			
Somerville Avenue and Poplar Street,	10.28	6	50
Charlestown:—			
Sullivan Square,	9.50	6	9
Junction of Somerville branch, foot of Arlington St.,	9.30	5	57
Charlestown Pumping Station,	9.02	5	47
Bellmouth, near Everett Station,	8.10	5	18

Somerville Branch.

Somerville:—			
Somerville-Medford line, Mystic Avenue,	10.85	7	53
Winthrop and Mystic avenues,	10.00	6	48

The size of sewers ranges from 15-inch pipe to 9-foot brick; the depth of flow ranges from 0.25 to 3.30 feet; the ratio of depth of flow to vertical diameter of sewer ranges from 13 to 36 per cent.

CHARLES RIVER VALLEY SYSTEM.

Approximately 226 miles of local sewers are now connected with this system, used by about 67,500 people, or 62.9 per cent. of the total population resident on the area. The following table gives additional facts in relation to the use of the Metropolitan Sewer by the tributary cities and towns:—

CHARLES RIVER VALLEY SYSTEM.

Table showing Cities and Towns delivering Sewage to this System; Approximate Miles of Sewer connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

CITIES AND TOWNS.	Miles of Local Sewer connected.	Separate or Combined.	Number of Connections with Local Sewers.	Estimated Number of Persons served by Each House-connection.*	Estimated Population now contributing Sewage.	Estimated Present Total Population.	Square Miles. Area now contributing Sewage.	Square Miles. Area ultimately to contribute Sewage.	Ratio of Contributing Population to Present Total Population.	Per Cent. 78.4	Ratio of Contributing Area to Ultimate Area.
Part of Boston (proper),	14.25	Separate and combined.	1,799	5.7	10,254	13,074	1.02	1.61	Per Cent. 63.3		
Boston (Brighton),	30.14	Separate and combined.	1,937	5.7	11,041	16,801	2.80	4.27	65.7		65.5
Brookline,	50.85	Combined, .	1,889	6.6	12,467	17,778	2.90	4.84	70.1		59.9
Newton,	72.45	Separate, .	2,950	5.1	15,045	29,634	5.00	13.60	50.8		36.7
Watertown,	21.52	Separate, .	1,020	4.7	4,794	7,992	1.52	4.04	60.0		37.6
Waltham,	37.15	Separate, .	2,480	5.6	13,888	21,966	2.36	13.63	63.2		17.5
	226.36	-	12,075	5.6	67,489	107,245	15.60	41.99	62.9		37.2

* This is estimated from assessors' statement of the number of houses in each city or town, and the population from census of 1895 extended to 1897.

During the year there has been expended for labor and supplies, in cleaning and maintaining the 8+ miles of sewer and special structures, \$1,659.49.

NEPONSET VALLEY SYSTEM.

The Neponset Valley Intercepting Sewer was opened into the Dorchester branch of the Boston Main Drainage Works on Aug. 23, 1897, by the removal of the bulkhead at Central Avenue. The Metropolitan Sewer from Central Avenue to near the West Roxbury line, 6.27 miles in length, is now (Sept. 30, 1897) discharging into Boston's sewers.

To date, 5 public connections from Hyde Park have been made with this system. Approximately $5\frac{1}{2}$ miles of local sewers, with 150 people in Hyde Park connected, are now tributary to this system.

The cost of maintenance to date for labor and supplies is \$207.23.

ENGINEERING STUDIES AND SUPPLIES.

Miscellaneous studies relating to all the systems have been made during the year, including preliminary study of a high-level sewer, and extensions to Wakefield, Stoneham and Lexington. Estimates and plans for additional pumps at all the stations have been prepared. Considerable study has been given to engine-records and flows in the sewers. Record maps of many of the completed contract sections have been made.

The above work, with clerical service in Engineer's office, office supplies and the expense of maintenance of the office building, No. 1 Mt. Vernon Street, has cost for the year \$9,188.14.

I desire to thank you for your continued courtesy and kindness during the year, and to express appreciation of the efficient service of all the employees in the engineering department.

Respectfully submitted,

WILLIAM M. BROWN, JR.,
Chief Engineer and Superintendent.

APPENDIX.

TABLE A. — *Miscellaneous Bids upon North Metropolitan Sewerage System.*

NAME OF BIDDER.	RESIDENCE.	CHARLESTOWN PUMPING STATION.		EAST BOSTON PUMPING STATION.		WAKEFIELD BRANCH.		DEER ISLAND PUMPING STATION.		STONEHAM BRANCH.	
		COAL. ¹ Bids opened Feb. 13, 1897.	COAL. ¹ Bids opened Feb. 13, 1897.	COAL. ¹ Bids opened Feb. 13, 1897.	COAL. ¹ Bids opened Feb. 13, 1897.	UNDEERDRAIN PIPE. Bids opened April 3, 1897.	SECTION 50. Bids opened April 24, 1897.	COAL. ¹ Bids opened May 1, 1897.	SECTION 51. Bids opened July 3, 1897.		
C. A. Campbell & Co., Sturtevant, Norton & Co., Garfield & Proctor Coal Co., Horatio Wellington & Co., Curran & Burton, Fiske, Homes & Co., D. W. Lewis, Long & Little, Berry & Ferguson, H. A. Hanscom & Co., E. E. Locke, Geo. D. Bell & Co., Curtis & Pope Lumber Co., Russo & Dotten, Portland Stoneware Co., Chas. A. & Chas. E. Trumbull, S. E. Benson & Co.,	Chelsea, Mass., Boston, Mass., Boston, Mass., Boston, Mass., Boston, Mass., Boston, Mass., Boston, Mass., Leominster, Mass., Boston, Mass., West Medford, Mass., Malden, Mass., Malden, Mass., Boston, Mass., Boston, Mass., Boston, Mass., Boston, Mass., Melrose, Mass.,	\$3 05* 3 19 3 40 3 49 3 50 — — — — — — — — — — — —	\$3 05* 3 23 3 40 — 3 50 — — — — — — — — — — — —	Discount. — — — — — 68 per cent., ² 71.2 per cent., ² 72.5 per cent., ^{2*} 72.5 per cent., ² — 73 per cent., ³ 73 per cent., ³ — 73 per cent., ⁴	— — — — — — — — — — — — — — — — — —	— — — — — — — — — — — — — — — — — —	\$2 83 ⁶ 2 86 ⁵ — — — — — — — — — — — — — — — — —	— — — — — — — — — — — — — — — — — —	— — — — — — — — — — — — — — — — — —		

Saucier & O'Brien,	Boston, Mass., .	-	-	-	-	10,636 30
W. G. Nash, .	Boston, Mass., .	-	-	-	-	-
P. & F. E. McCarthy,	Boston, Mass., .	-	-	-	-	10,608 76
Harry Stevens, .	Melrose, Mass., .	-	-	-	-	-
Raymond B. Malone,	Mt. Auburn, Mass., .	-	-	-	-	10,052 12
E. B. Townsend, .	Boston, Mass., .	-	-	-	3 11 ⁵	-
Bruno & Solome, .	East Boston, Mass., .	-	-	-	-	9,883 55
John Morrison, .	East Boston, Mass., .	-	-	-	2 76 ^{7*}	-
James J. Newman,	Providence, R. I., .	-	-	-	-	-
Frank L. Allen,	Worcester, Mass., .	-	-	-	-	-
Cheney & Trumbull,	Boston, Mass., .	-	-	-	\$21,463 35	11,574 80
E. W. Everson & Co.,	Boston, Mass., .	-	-	-	20,129 50	-
T. F. Lynch & Co.,	Boston, Mass., .	-	-	-	19,452 80	-
A. W. Byrne Construc-	Boston, Mass., .	-	-	-	19,004 50	-
tion Co., .	West Medford, Mass.,	-	-	-	18,474 60	-
Chas. G. Craib, .	Winthrop, Mass., .	-	-	-	17,764 80	9,042 00*
Vincent Solomone,	Waltham, Mass., .	-	-	-	17,113 50	-
Aab & Co., .	Waltham, Mass., .	-	-	-	16,985 78	-
S. W. Frescoln, .	Reading, Pa., .	-	-	-	16,656 02	-
John Booth Co., .	Winchester, Mass., .	-	-	-	16,438 72	9,863 10
Felton and Holbrook,	Boston, Mass., .	-	-	-	14,899 00*	-
Cabot & Daly, .	Boston, Mass., .	-	-	-	-	9,231 00

* Contract awarded.

† Bid withdrawn.

1 Per long ton (2,240 lbs.).

² Akron pipe.³ Portland pipe.⁴ Granite pipe.⁵ New Central George's Creek.⁶ George's Creek or New River.⁷ New River.

TABLE B. — *Miscellaneous Bids upon the Neponset Valley System.*

NAME OF BIDDER.	RESIDENCE.	BIDS OPENED MAY 22, 1897.			
		UNDERDRAIN PIPE.	Section 26, Dedham and West Roxbury.	Section 27, West Roxbury.	Section 28, West Roxbury.
		Sections 26-29. Bids opened April 3, 1897.			
		Discount.			
Fiske, Homes & Co.,	Boston, Mass.,	68 per cent., ¹	—	—	—
D. W. Lewis,	Boston, Mass.,	68 per cent., ¹	—	—	—
Portland Stoneware Co.,	Boston, Mass.,	68 per cent., ²	—	—	—
Waldo Brothers,	Boston, Mass.,	68 per cent., ¹	—	—	—
Dorchester Building Material Co.,	Boston, Mass.,	72½ per cent., ¹	—	—	—
Curtis & Pope Lumber Co.,	Boston, Mass.,	73 per cent., ²	—	—	—
W. G. Nash,	Boston, Mass.,	75 per cent., ^{3*}	—	—	—
T. H. Bryne & Co.,	Hyde Park, Mass.,	—	\$82,394 00	\$62,705 00	\$22,472 25
Frank L. Allen,	Worcester, Mass.,	—	65,167 00	42,877 50	38,032 00
Long & Little,	Leominster, Mass.,	—	56,043 50	37,530 00	30,867 50
James J. Newman,	Providence, R. I.,	—	52,032 50	33,274 75	37,155 70
Edward W. Everson & Co.,	Providence, R. I.,	—	51,939 50	34,290 00	39,228 00
George W. Judd,	Boston, Mass.,	—	51,295 23	35,911 00	43,294 38
D. F. O'Connell,	Boston, Mass.,	—	49,931 45	33,090 25	29,886 00
J. P. O'Connell,	Boston, Mass.,	—	49,132 50	32,253 75	31,779 75
Charles G. Craib,	Winthrop, Mass.,	—	44,021 00	—	—
S. W. Frescoln,	Reading, Pa.,	—	39,932 05	—	—
National Contracting Co.,	New York, N. Y.,	—	38,961 35*	24,443 00*	26,121 90
T. F. Lynch & Co.,	Boston, Mass.,	—	—	—	26,079 75†
					16,440 85
					—
					—

* Contract awarded.

¹ Akron pipe.

² Portland pipe.

³ Granite pipe.

† Bid withdrawn (awarded to Felton and Holbrook, Cabot & Daly, at same figures).

TABLE C.—*Sections upon North Metropolitan and Neponset Valley Systems.*

SECTION.	LOCATION.	Advertised for Bids.	Bids opened.	Number of Bids.	Highest.	Lowest.
Section 50,	Wakefield Branch, . . .	April 7, 1897,	April 24, 1897,	11	\$21,463 35	\$14,899 00
51,	Stoneham Branch, . . .	June 23, 1897,	July 3, 1897,	13	12,074 50	9,042 00
26,	Dedham and West Roxbury,	May 9, 1897,	May 22, 1897,	11	82,394 00	38,961 35
27,	West Roxbury,	May 9, 1897,	May 22, 1897,	9	62,705 00	24,443 00
28,	West Roxbury,	May 9, 1897,	May 22, 1897,	10	65,136 00	26,079 75
29,	West Roxbury,	May 9, 1897,	May 22, 1897,	9	30,322 50	16,440 85
					\$274,095 35	\$129,865 95

TABLE C. — *Sections upon North Metropolitan and Neponset Valley Systems — Concluded.*

SECTION.	LOCATION.	Contract awarded to —	Residence.	Amount bid on Items for Comparison.	Work begun.	To be completed.	Length of Section.
Section 50, .	Wakefield Branch,	John Booth Co., .	Winchester, Mass., .	\$14,899 00	May 10, 1897,	Nov. 1, 1897,	Feet. 4,685
51, .	Stoneham Branch,	A. W. Bryne Construc- tion Co.	West Medford, Mass.,	9,042 00	July 15, 1897,	Jan. 1, 1898,	4,135
26, .	Dedham and West Roxbury.	National Contracting Co.,	New York, N. Y., .	38,961 35	June 24, 1897,	March 1, 1898,	4,075
27, .	West Roxbury, .	National Contracting Co.,	New York, N. Y., .	24,443 00	June 10, 1897,	Jan. 1, 1898,	3,440
28, .	West Roxbury, .	Felton and Holbrook, Cabot & Daly.	Boston, Mass., .	26,079 75	June 9, 1897,	April 1, 1898,	4,575
29, .	West Roxbury, .	D. F. O'Connell, .	Boston, Mass., .	16,440 85	June 21, 1897,	June 1, 1898,	4,700
				<u>\$129,865 95</u>			

[illegible]

[illegible]

	\$1,777 08	4,063 96	73,355 94	\$95,081 22
Sept.				
By pay rolls for month, general,
By supplies for month, general,
By pay rolls for month, Deer Island,
By supplies for month, Deer Island,
By pay rolls for month, East Boston,
By supplies for month, East Boston,
By pay rolls for month, Charlestown,
By supplies for month, Charlestown,
By pay rolls for month, Alewife Brook,
By supplies for month, Alewife Brook,
By proportionate expenses, commissioners, chief engineer, clerk and others, for month,
Balance,
	\$1,777 08	4,063 96	73,355 94	\$95,081 22

TABLE E. — *Maintaining and Operating Charles River Valley System.*

1896. Oct. 1,	DR.					\$
	To balance from appropriation for 1896,	.	.	.	.
						\$12,067 01
1897. Feb. 2, 11,	To appropriation made by chapter 42, Acts of 1897,	.	.	.	.	\$31,000 00
	To appropriation made by chapter 61, Acts of 1897,	.	.	.	.	1,857 07
						32,857 07
1896. Oct. 31, 31, 31, 31,	CR.					\$45,924 08
	By amount paid city of Boston for disposing of sewage to Oct. 1, 1896,	.	.	.	.
	“ “ for salaries, commissioners, etc., to date,	.	.	.	.	\$6,750 00
	“ “ for labor for month,	.	.	.	.	50 00
	“ “ for supplies for month,	.	.	.	.	220 00
Nov. 30, 30, 30, 30,						7 22
						\$7,027 22
	By amount paid for salaries, commissioners, etc., to date,	.	.	.	.	\$50 00
	“ “ for labor for month,	.	.	.	.	371 00
Dec. 31, 31, 31,	“ “ for supplies for month,	.	.	.	.	13 05
	“ “ for one quarter's rental of office telephone,	.	.	.	.	45 00
						479 05
Dec. 31, 31, 31,	By amount paid for salaries, commissioners, etc., to date,	.	.	.	.	\$50 00
	“ “ for labor for month,	.	.	.	.	226 00
	“ “ for supplies for month,	.	.	.	.	7 14
						283 14

1897. Jan. 31,	By amount paid for salaries of apportionment commissioners, by order of court (25 per cent.),	\$750 00	
	“ “ Alfred Mudge & Son (printing for said commission),	370 67	
	“ “ city of Boston for disposing of sewage to Jan. 1, 1897,	6,750 00	
	“ “ for supplies for month,	14 00	7,884 67
Feb. 28,	By amount paid for labor for month,	\$78 00	
	“ “ for supplies for month,	5 40	83 40
Mar. 31,	By amount paid for salaries, commissioners, etc, to date,	\$333 34	
	“ “ for labor for month,	112 50	
	“ “ for supplies for month,	6 50	452 34
April 30,	By amount paid for salaries, commissioners, etc., to date,	\$125 00	
	“ “ city of Boston for disposing of sewage to April 1, 1897,	6,750 00	
	“ “ for labor for month,	90 00	
	“ “ for supplies for month,	9 83	6,974 83
May 31,	By amount paid for salaries, commissioners, etc, to date,	\$516 66	
	“ “ for labor for month,	90 00	
	“ “ for supplies for month,	1 10	607 76
<i>Amounts carried forward,</i> . . . . .		. . .	\$23,792 41
			\$45,924 08

TABLE F — *Maintaining and Operating Neponset River Valley System.*

		Dr.		Cr.			
1896.							
Feb. 15,	To appropriation made by chapter 85, Acts of 1896, . . . . .	.	.	.	.	.	\$2,500 00
1897.							
February,	To appropriation made by chapter 43, Acts of 1897, . . . . .	.	.	.	.	.	4,500 00
							<u>\$7,000 00</u>
1897.							
Jan. 31,	By amount paid Rogers & Jones, stenographers, apportionment expenses, . . . . .	.	.	.	.	\$232 50	
31,	“ “ for salaries of apportionment commissioners (paid by order of court), . . . . .	.	.	.	.	450 00	\$682 50
March 31,	By amount paid for salary of assistant engineer for month, . . . . .	.	.	.	.	\$75 00	
31,	“ “ for salaries of commissioners for month, . . . . .	.	.	.	.	250 00	325 00
April 30,	By amount paid for salary of assistant engineer for month, . . . . .	.	.	.	.	\$75 00	
30,	“ “ for supplies for month, . . . . .	.	.	.	.	9 25	84 25
May 31,	By amount paid for labor for month, . . . . .	.	.	.	.	\$66 00	
31,	“ “ for salary of assistant engineer for month, . . . . .	.	.	.	.	75 00	
31,	“ “ for supplies for month, . . . . .	.	.	.	.	5 76	146 76
	<i>Amounts carried forward,</i> . . . . .	.	.	.	.	\$1,238 51	<u>\$7,000 00</u>

DISBURSEMENTS BY YEARS TO SEPT. 30, 1897.

	Year ending Sept. 30, 1889.	Year ending Sept. 30, 1890.	Year ending Sept. 30, 1891.	Year ending Sept. 30, 1892.	Year ending Sept. 30, 1893.	Year ending Sept. 30, 1894.	Year ending Sept. 30, 1895.	Year ending Sept. 30, 1896.	Year ending Sept. 30, 1897.	Totals.
Office expenses,	\$1,161 29	\$28,792 85	\$30,437 29	\$31,220 76	\$35,191 97	\$33,669 39	\$19,652 19	-	-	-*
North Metropolitan System,	-	116,492 55	582,966 06	962,798 49	1,172,269 02	1,115,190 19	606,488 61	\$400,349 58	\$42,023 27	\$4,998,577 77
Charles River Valley System,	-	18,329 41	331,149 33	230,308 29	28,882 27	25,369 13	1,927 35	52,831 53	325 21	789,122 52
Both systems,	-	2,696 20	5,597 86	7,703 15	12,783 61	15,864 20	302 20	-	-	-*
Neponset Valley System,	-	-	-	-	-	-	2,649 95	200,604 35	405,486 31	608,740 61
Wakefield branch,	-	-	-	-	-	-	-	125 98	27,199 11	27,325 09
Stoneham branch,	-	-	-	-	-	-	-	-	2,802 68	2,802 68
	\$1,161 29	\$166,311 01	\$1,000,150 54	\$1,282,030 69	\$1,249,126 87	\$1,190,092 91	\$631,020 30	\$653,911 44	\$477,836 58	\$6,426,568 67
Total expended to Sept. 30, 1897,										\$6,426,568 67

* The accounts "Office expenses" and "Both systems" are charged off to the North Metropolitan System and the Charles River Valley System, — 85 per cent to the former and 15 per cent to the latter (North Metropolitan System, \$191,312 02, Charles River Valley System, \$33,760 94). This is the proportion made by the apportionment commission in 1891 and has been found by experience to be substantially correct.

Land takings, purchase and recording.	-	-	-	-	14,506 95	-	-	-	\$487 25	-	-	18,802 80
Legal services,	-	-	-	-	113 00	-	-	-	99 25	-	-	212 25
Experts and appraisers, . . .	-	-	-	-	25 00	-	-	-	144 84	-	-	169 84
Field supplies,	-	-	-	-	22 10	-	-	-	14 60	-	-	36 70
Advertising,	-	-	-	-	52 80	-	-	-	-	-	-	52 80
Alewife Brook coal-pocket, . .	-	-	-	-	57 00	-	-	-	-	-	-	57 00
Widow of Stephen Healy, . . .	-	-	-	-	-	-	-	-	4,000 00	-	-	4,000 00
Totals,	\$1,804 78	\$2,269 23	\$811 55	\$4,316 80	\$15,653 42	\$8,935 30	-	\$3,486 25	\$4,745 94	-	-	\$42,023 27

EXPENSES OF BOARD OF METROPOLITAN SEWERAGE COMMISSIONERS FOR THE YEAR ENDING SEPT. 30, 1897 — *Continued.*

Neponset Valley System.

	1896.				1897.								Totals.
	Oct.	Nov.	Dec.										
				Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	
Salaries—engineers, inspectors, rodmen, laborers and others.	\$4,681 90	\$3,968 19	\$3,736 90	\$3,823 40	\$4,915 41	-	\$3,636 06	-	\$3,718 66	\$4,069 79	-	\$3,456 28	\$36,006 59
Section No. 12,	2,392 41	853 38	1,078 54	1,433 83	46 94	\$36 20	15 08	-	6 42	2 18	-	32 26	5,997 24
Section No. 13,	4,117 28	552 80	-	3,246 31	-	5 00	1,012 50	-	-	583 24	-	-	9,517 13
Section No. 14,	4,370 41	26 20	21 60	5 68	8 00	-	903 30	\$105 46	10 00	-	-	4 93	5,455 58
Section No. 15,	9,635 93	1,581 29	-	2,252 77	28 00	-	1,020 25	-	-	452 02	-	-	14,970 26
Section No. 16,	2,358 60	4,257 54	6,002 57	2,316 72	2,939 63	2,374 77	4,257 26	3,772 00	-	-	\$6 11	11 40	23,296 60
Section No. 17,	4,886 36	5,023 94	3,118 76	94 29	822 60	1,309 10	2,248 97	702 22	3,201 50	2 88	-	-	21,410 62
Section No. 18,	4,398 15	5,428 01	26 00	162 26	-	-	2 50	1,927 46	-	-	5 18	-	11,949 56
Section No. 19,	5,416 63	6,980 31	1,364 74	1,403 74	2,636 86	-	3,503 89	600 00	-	719 28	3 00	5 00	22,633 45
Section No. 20,	6,839 80	36 63	4,918 11	5,344 42	5,078 97	39 00	3,582 45	737 68	172 40	-	-	3 25	26,752 71
Section No. 21,	8,986 17	6,297 68	2,346 08	195 16	-	-	-	4,394 98	-	-	-	-	22,220 07
Section No. 22,	3,771 35	4,297 13	3,124 68	121 44	-	-	2,959 70	3,343 84	3,579 56	5,039 39	-	20 40	25,277 49
Section No. 23,	3,006 54	1,463 50	1,487 75	3,437 97	2,306 49	3,672 60	3,805 65	6,885 84	2,786 16	3,179 52	2,395 40	1,209 55	35,636 97
Section No. 24,	5,780 57	6,849 91	4,095 03	6,206 32	1,183 78	1,020 71	21 00	3,590 54	1,207 23	2,153 55	1,266 64	3,601 17	36,976 50
Section No. 25,	7,372 95	129 23	7,477 40	7,879 90	1,208 74	107 53	4,796 68	3,659 82	77 78	-	57 64	3 99	32,771 66
Section No. 26,	-	-	-	-	-	-	-	-	-	1,719 85	2,988 02	2,764 57	7,472 44
Section No. 27,	-	-	-	-	-	-	-	-	-	1,903 55	2,186 55	3,077 00	7,167 10

Section No. 28,	-	-	-	-	-	-	-	-	-	3,002 00	8,932 90	9,743 75	21,078 65
Section No. 29,	-	-	-	-	-	-	-	-	-	195 86	3,503 27	7,614 38	11,315 26
Maps, plans and blue-prints, .	19 00	-	7 25	-	-	18 39	20 01	-	-	2 00	-	-	67 28
Office supplies,	231 41	94 13	14 96	149 22	103 61	76 77	76 19	79 92	4 85	123 88	46 11	77 48	1,078 53
Carriage hire,	58 00	-	-	24 50	18 00	-	20 00	-	13 50	45 00	38 50	25 00	242 50
Photography,	25 64	27 93	-	85 25	-	6 42	40	-	-	-	-	20 52	166 16
Commissioners,	250 00	250 00	250 00	-	750 00	250 00	-	750 00	250 00	-	750 00	250 00	3,750 00
Clerk and chief engineer, .	516 66	516 66	516 68	516 66	-	308 34	516 66	-	308 34	516 66	-	308 34	4,025 00
Field supplies,	113 12	84 37	13 20	250 61	6 40	71 50	134 05	146 64	27 79	329 85	1,505 94	278 77	2,962 24
Repairs, fittings and supplies at building, No. 1 Mt. Vernon St.	19 80	35 49	5 00	126 00	-	-	49 91	-	10 00	-	-	21 67	267 87
Travelling expenses,	285 45	67 58	40 54	300 45	4 30	261 00	223 61	20 00	75 30	55 90	103 80	33 79	1,471 72
Teaming and express,	40 55	50	1 00	50	70	-	35 95	-	80	30	100 17	70 25	250 72
Boat hire,	7 15	-	-	-	-	-	-	-	-	-	-	-	7 15
Tools and repair of same, .	3 65	35	3 95	2 70	-	-	10 55	-	2 65	-	-	2 70	26 55
Postage, telegrams and telephone.	4 37	15	7 86	2 10	50	-	5 07	-	1 25	2 15	-	47 20	70 65
Clerical services,	-	125 00	125 00	50 00	125 00	-	50 00	125 00	-	50 00	125 00	1 50	776 50
Engineers' instruments and repair of same.	-	11 07	-	-	-	-	22 35	-	-	-	-	2 90	36 32
Advertising,	-	-	-	97 90	-	-	-	-	56 80	17 20	-	-	171 90
Land takings, purchase and recording.	-	-	-	77 00	2,250 00	-	343 95	-	811 80	324 08	-	1,043 51	4,850 34
Experts and appraisers, . .	-	-	-	225 00	-	-	135 00	-	-	172 50	-	-	532 50
Legal services,	-	-	-	-	-	-	86 00	-	10 00	230 50	-	-	326 50
Totals,	\$79,589 85	\$48,958 97	\$39,783 65	\$39,832 10	\$24,452 32	\$9,558 95	\$33,477 36	\$30,841 40	\$16,332 79	\$24,913 13	\$24,014 23	\$33,731 56	\$405,486 31

EXPENSES OF BOARD OF METROPOLITAN SEWERAGE COMMISSIONERS FOR THE YEAR ENDING SEPT. 30, 1897 — *Concluded.*

Wakefield Branch.

	1896.			1897.									Totals.
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	
Salaries — engineers, inspectors, rodmen, laborers and others.	-	\$250 37	-	-	-	\$165 00	-	-	-	\$543 08	-	-	\$958 45
Melrose sewers,	-	15,000 00	-	-	-	-	-	-	-	-	-	-	15,000 00
Tools and repair of same,	-	-	-	-	-	1 05	-	-	-	-	-	-	1 05
Travelling expenses,	-	14 25	-	-	-	14 70	-	-	-	5 03	-	-	33 98
Office supplies,	-	-	-	-	-	60	-	-	-	83 50	-	-	84 10
Teaming and express,	-	-	-	-	-	2 25	-	-	-	10 00	-	-	12 25
Field supplies,	-	-	-	-	-	4 85	-	-	-	214 32	-	-	219 17
Maps, plans and blue-prints,	-	-	-	-	-	10 95	-	-	-	-	-	-	10 95
Land takings, purchase and recording.	-	-	-	-	-	4 00	-	-	-	-	-	-	4 00
Advertising,	-	-	-	-	-	-	-	-	-	33 00	-	-	33 00
Section 50,	-	-	-	-	-	-	-	-	\$2,237 52	2,806 17	\$3,104 28	\$2,682 95	10,830 92
Office expenses,	-	-	-	-	-	-	-	-	-	10 60	-	-	10 60
Postage, telephone and telegrams,	-	-	-	-	-	-	-	-	-	64	-	-	64
Totals,	-	\$15,264 62	-	-	-	\$203 40	-	-	\$2,237 52	\$3,706 34	\$3,104 28	\$2,682 95	\$27,199 11

Stoneham Branch.

Advertising,	-	-	-	-	-	-	-	-	-	\$32 50	-	\$32 50
Office expenses,	-	-	-	-	-	-	-	-	-	37 56	-	37 56
Section 51,	-	-	-	-	-	-	-	-	-	-	\$2,732 62	2,732 62
Totals,	-	-	-	-	-	-	-	-	-	\$70 06	\$2,732 62	\$2,802 68

Charles River Valley System.

Section E,	\$7 71	-	-	-	-	-	-	-	-	-	-	\$7 71
Section F,	49 50	-	-	-	-	-	-	-	-	-	-	49 50
Legal services,	-	-	-	-	-	-	-	-	-	\$18 00	-	18 00
Land takings, purchase and recording,	-	-	-	-	-	-	-	-	-	250 00	-	250 00
Totals,	\$57 21	-	-	-	-	-	-	-	-	\$268 00	-	\$325 21

ASSETS AND LIABILITIES SEPT. 30, 1897.

ASSETS.

Office furniture, fittings and supplies, including fittings for field offices, stationery and railroad tickets,	\$2,922 27
Engineering instruments and supplies,	2,181 75
Engines, pumps, boilers, derricks, inclines, buckets, row-boats, dump-cars and heavy appliances,	3,063 00
Pumping station fixtures, tools and supplies,	6,310 78
Miscellaneous tools,	909 80
Engineers' field offices, sheds, barns and tool-houses, . .	1,495 00
Miscellaneous supplies,	1,418 00
Carts, express wagon, horse and harnesses,	350 00
Stock yard and building, East Boston,	2,500 00
Land for stock yard, Hyde Park,	167 00
Vacant lots, Winthrop,	1,800 00

Cash received as follows:—

Balance Sept. 30, 1896,	\$3,154 16
To sale of pile butts, wood, iron, etc.,	85 36
sale of kerosene and naphtha,	9 04
sale of engineer and inspectors' field office,	30 00
sale of house and lot, 63 Pearl Street, Chelsea, final payment,	1,500 00
engineer's transit,	125 00
laying pipe, etc.,	45 12
use of incline plane,	25 00
town of Hyde Park, expense of constructing man-hole,	128 52
city of Boston, for one-half cost of man-hole,	50 00
Boston Transit Commission, four tunnel trucks and 10,688 pounds track,	63 44
city of Medford, for pumping ground-water for underdrain,	109 50
	<hr/>
	5,325 14
	<hr/>
	\$28,442 74

There are numerous necessary plans, drawings, calculations and studies relating to the work to which no stated value can be assigned; also about sixty-three miles of completed sewer, with pumping stations, siphons and other accessories necessary for operating the systems.

LIABILITIES.

Amounts due contractors : —

Reserved on estimates (sewers),	\$23,708 12
Fraction of pay rolls (engineers)	727 35
Fraction of pay rolls (laborers),	173 27
Unpaid bills, miscellaneous,	1,560 18
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	\$26,168 92

There are also amounts due contractors upon a very few sections of the work which will be paid on succeeding estimates or after the completion of the contracts.

B. P. L. Binder
FEB 21 1909

